AN ENERGY OVERVIEW STUDY FOR FOND-DU-LAC , SASKATCHEWAN

86-05619/

AN ENERGY OVERVIEW STUDY

FOR FOND-DU-LAC, SASKATCHEWAN

with special emphasis on
energy efficient construction and renovation techniques
and wood heating safety

Prepared for:

Fond-du-Lac Indian Band

Prepared by:

Eneraction Resources Incorporated

With a contribution from:

Remote Community Demonstration Program
of Energy, Mines and Resources Canada

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RCDP/PDCE-46

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ABBREVIATIONS USED IN REPORT

CMHC	Canada Mortgage and Housing Corporation
CHIP	Canadian Home Insulation Program
^{o}C	Degrees Celsius
INAC	Indian and Northern Affairs Canada
m	metres
RCDP	Remote Community Demonstration Program
RRAP	Residential Rehabilitation Assistance Program
RSI	Resistance System International

EXECUTIVE SUMMARY

Introduction:

From May to October, 1984 Eneraction Resources, Inc., conducted a study of the energy use, needs and alternatives of the housing located in Fond-Du-Lac, Saskatchewan.

Meetings were held with community leaders and construction crews to discuss the findings of this study and advise the crews on energy conservation techniques. An analysis was also completed on the costs of retrofitting the 'average' home and various funding programs were identified.

A Community Handbook was also prepared which is a reference guide for use by the community on energy conservation and wood heating in their homes.

Findings:

1. Houses have not been built to the Arctic Housing energy standards required for the Fond-Du-Lac area.

2. All houses do not have enough insulation in the walls, attics or floors.

3. Homes need better weatherstripping around doors and windows.

4. Construction crews need to be trained on how to properly install air vapour barriers, otherwise, the new housing will fall apart because of moisture getting into the walls and attic.

5. Chimneys in many homes have never been cleaned.

Recommendations:

1. New homes should be built to Arctic Housing Energy Standards.

2. Existing housing should have a higher level of insulation installed and they should be made more airtight.

3. A training program for local construction crews on how to properly build an energy efficient home should be implemented.

4. Stoves and chimneys should be checked out more often - chimneys should be checked and cleaned at least twice a year. Also, in the future, all wood stoves which are purchased should be the airtight design or central wood furnaces.

Funding:

1. Funds are available from a number of government programs which can pay for most of the costs of installing extra insulation and weatherstripping in existing homes.

ETUDE GENERALE DES QUESTIONS ENERGETIQUES POUR LA COLLECTIVITE DU FOND-DU-LAC (SASKATCHEWAN)

visant les techniques de construction et de rénovation à bon rendement énergétique et la sécurité en chauffant au bois

De mai à octobre 1984, Eneraction Resources, Inc. a mené une étude de la consommation et des besoins d'énergie des maisons situées à Fond-du-Lac, en Saskatchewan, ainsi que des options énergétiques pour ces maisons.

Les dirigeants de la collectivité et des hommes de métier ont été conviés à des réunions où les résultats de cette étude ont été examinés et où des conseils relatifs aux techniques d'économie d'énergie ont été donnés. Une analyse des coûts de modernisation d'une maison "moyenne" a également été faite et différents programmes de financement ont retenu l'attention.

Enfin, un guide de référence a été préparé à l'intention de la collectivité pour ce qui est de l'économie d'énergie dans les maisons et du chauffage au bois.

Les résultats étaient:

1. Des maisons n'ont pas été construites en fonction des normes énergétiques qui sont en vigueur dans la région de Fond-du-Lac.

2. Toutes les maisons n'ont pas suffisamment d'isolation dans les murs, l'entretoit et les planchers.

3. Des maisons ont besoin de coupe-bise autour des portes et des fenêtres.

4. Il faut organiser des stages de formation à l'intention des hommes de métier pour leur montrer comment installer des coupe-vapeur, sinon, les nouvelles maisons vont se détériorer prématurément en raison de l'infiltration d'humidité entre les murs et dans l'entretoit.

Les recommandations sont:

1. Les maisons existantes devraient être davantage isolées et calfeutrées.

2. Les nouvelles maisons devraient être construites en fonction de normes d'économie d'énergie beaucoup plus élevées.

3. Les poêles et les cheminées devraient être inspectés plus souvent: les cheminées devraient être inspectées et nettoyées au moins deux fois par année. De plus, aux fins du chauffage au bois, il faudrait dorénavant acheter uniquement des poêles hermétiques et des générateurs d'air chaud à combustion contrôlée.

Il est possible d'obtenir des fonds en vertu de plusieurs programmes gouvernementaux, lesquels couvrent la plupart des coûts.

Cette étude a été exécutée par Eneraction Resources Inc., pour le compte de la collectivité de Fond-du-Lac et grâce à une contribution du Programme de démonstration dans les collectivités éloignées d'Énergie, Mines et Ressources Canada.

1.0 INTRODUCTION

Eneraction Resources Inc. was contracted by the Fond-Du-Lac band (under the R.C.D.P. program) to assist the community in identifying practical, cost-effective ways of reducing its dependence on high cost heating oil and propane and electricity. This objective was to be satisfied by:

(a) Identifying areas of energy waste in residential buildings;
(b) Identifying improvements or retrofit measures that could be implemented to reduce energy losses in residential buildings;
(c) Informing and educating the community in energy conservation practices for energy efficient construction, and in safe heating practices.

This report describes the tasks which were carried out to satisfy the objective.

2.0 Work Task I

2.1 Housing Stock

The housing stock in the community was categorized by year of construction, occupancy and general house condition. This was done with the aid of the community coordinator, Mr. Donald Duronger, and an analysis of a Survey of Housing Conditions conducted by The Department of Indian Affairs in 1982. A list of housing units by year of construction is found in Appendix I.

2.2 Checklist

An evaluation checklist was developed in order to assess the community's houses with regard to energy performance, and from which an analysis of retrofit needs could be determined. The first section is a homeowner

questionnaire which identifies specific concerns the family has about energy related problems, as well as indicating the awareness the occupants have of energy use and function. The second and third sections of the checklist document the physical condition and dimensions of the structure for further analysis.

The checklist was developed to be used by Eneraction for assessing fifteen homes, as well as by the community coordinator for gathering information on the remaining homes in the community.

The community coordinator and a translator accompanied the consultant to the fifteen homes. These individuals provided translation and interpretation.

The fifteen homes represented different materials, construction techniques, year of construction and heating systems. A list of the homes visited and a copy of the checklist is in Appendix II and III, respectively.

2.3 New Construction Seminar

Housing construction begins about June 1 in Fond-Du-Lac. The community coordinator therefore requested that the new construction seminar be given to the construction crew during the first visit, May 28-31. A seminar was prepared, consisting of slides of relevant construction practices, blueprint details and written materials for distribution to the building crew. Copies of relevant materials may be found in the Community Handbook.

The main emphasis of the seminar was to explain the relationship among airtightness, vapour barrier and insulation in the building structure, and also to demonstrate construction techniques which will improve the building technology for better energy efficiency.

The new construction seminar was delivered to the building crew and construction foreman. The timing

of this seminar was appropriate as the consultant had the opportunity to assess current new housing practices from the previous year's construction, the available skills, materials, and building practices. The new building seminar was geared to demonstrate the most appropriate skills and materials necessary for immediate improvement of construction practices.

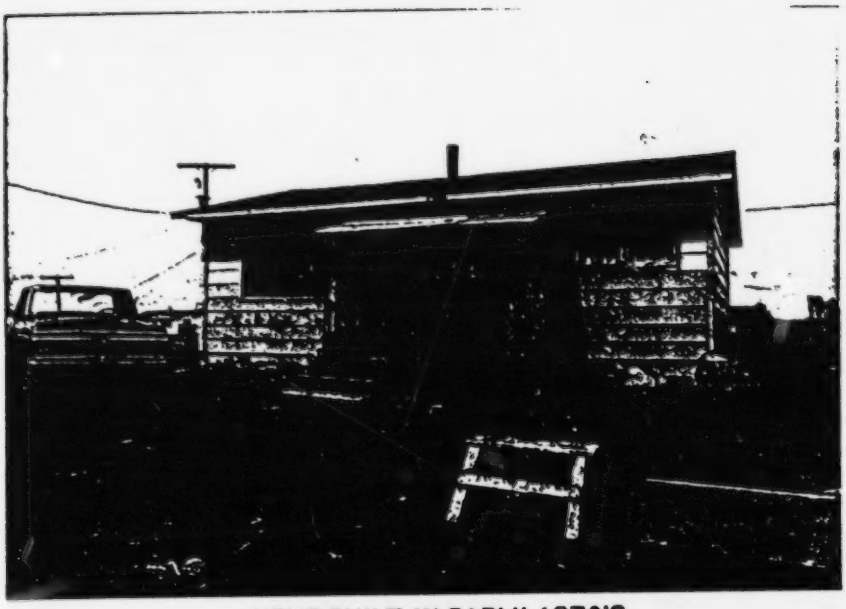
3.0 Work Task II

3.1 Analysis of Housing Data

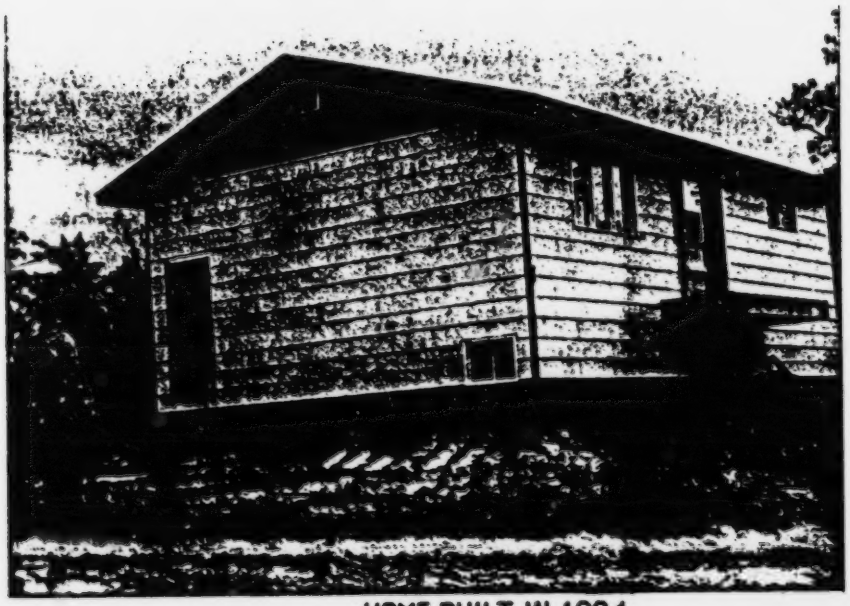
The original contract work statement required that the retrofit strategies suggested for Fond-Du-Lac be based on The Arctic Housing Standard and that various retrofit recommendations be analyzed for five, ten and fifteen year paybacks. This cost payback analysis is not possible for two reasons: first, the major energy supply for residential space heating is wood, which is obtained at no direct cost by the home occupants from the forest. Second, the housing stock is generally in such poor condition that basic improvements are required to improve living conditions, and to increase the life span of the housing stock.

The Fond-Du-Lac climate is severe, even by south Saskatchewan standards. The heating season, measured at Uranium City (100 miles away) is 7,860 Celsius degree days, and a 5% January design temperature of $-39^{0}C$. (i.e. 5% of the time it is colder than $-39^{0}C$).

There are presently 111 homes in the community, all of which have been constructed since 1964. The homes are situated on a site sloping south, positioned in an irregular pattern across the sandy, tree-cleared community. Sewer and water services are not available and electricity is limited in capacity, providing only 110 volt service to homes.



HOME BUILT IN EARLY 1970'S



HOME BUILT IN 1984

The houses are all bungalows, typically 7.3 m wide by 9.8 m long (24' x 32'). The house styles, building techniques and construction materials have not varied substantially from year to year, although the 43 homes constructed since 1980 have introduced some new concepts such as basements and bi-level designs. The condition of the housing stock varies greatly depending on occupant maintenance and year of construction. The results of the housing survey can be found in Appendix IV.

3.2 Analysis Of Housing Stock-Conclusions

A detailed analysis of the housing stock is in Appendix V.

3.2.1 Foundations and Floors

Conclusions: Foundation walls and floors over crawlspaces are typically insulated far below The Arctic Housing Standards of RSI 6.22 for floors over an unheated crawlspace or RSI 1.75 minimum for foundation walls to 250 mm above grade. Construction procedures to erect wood foundation walls or wood basements have not been correctly applied and education of the construction crew is necessary to improve procedures. Crawl space venting is often larger than required and is not controlled with a damper.

3.2.2. Above Grade Walls and Roof Structures

Conclusions: Insulation in all sample homes constructed prior to 1980 was RSI 2.1 or less, in both the walls and the attic. This quantity of insulation is not sufficient for this climate and far below The Arctic Housing Standard level. The homes in the sample which were constructed since 1980 had their walls insulated to RSI 3.5 and attics to RSI 7.0, RSI 10.9, and one 1982 house which had RSI 0 over most of the attic space. The construction crew indicated that new homes were

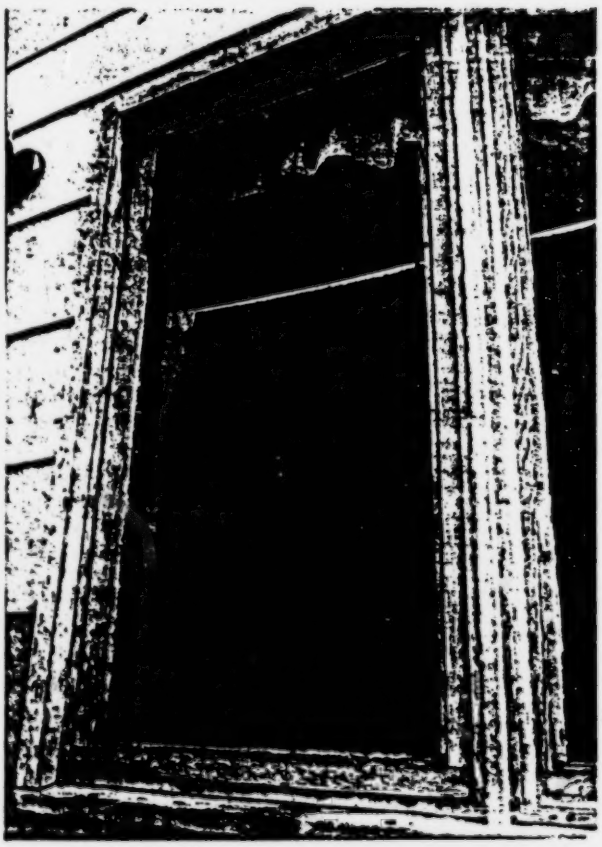
supposed to have attic insulation levels of RSI 7.0. Even the greater amount of insulation present in the walls of the new construction (RSI 3.5) does not meet the minimum requirement for energy efficient arctic housing. The attic insulation in new construction exceeds the proposed minimum arctic standard for this region.

3.2.3 Doors and Windows

Conclusions: Doors and windows are inadequate in all the homes surveyed. Higher quality windows and doors, equipped with proper weatherseals, and triple glazing should be provided for future construction and retrofit to existing dwellings as necessary. A standard set of window sizes does not exist in the community.

3.2.4 Air-Vapour Barriers, Moisture Damage and Airtightness

Conclusions: Air leakage in these homes is extremely high and is causing rapid structural deterioration and discomfort to the occupants. The technical relationships between air-vapour barrier and insulation does not appear to be understood by the occupants or the construction crew. Homes built prior to 1980 suffer more from poor insulation and high air leakage, but are less susceptible to the wet/dry cycle because of the wood panel and plywood interiors from which they were constructed. Homes built since 1980, with great amounts of insulation, interior finish of gyproc material, and wood foundations, will deteriorate much more rapidly if improved air vapour barriers are not installed.



Window showing Wood Frame

EXTERIOR DOORS - NOTE THAT THE SCREEN HAS BEEN REMOVED AND REPLACED WITH A SHEET OF PLYWOOD.

3.2.5 Heating

Conclusions: The basic stove technology used in these homes is adequate considering the cost of the alternative space heating fuel such as oil, and considering the abundance of local firewood. The stoves and chimneys have not been maintained regularly and there is no local stocking of replacement parts. The central furnaces installed in the new 1983 homes will be a significant improvement in comfort due to the central forced air system and the improved burning technology.

3.3 Recommendations For Action

The problems and constraints of higher quality housing in the community relate to:

- the lack of adequate resources allocated to housing
- inadequate construction quality and inadequate building inspection
- inappropriate building components
- lack of skill and/or knowledge for the specific task
- inadequate local inventory of building hardware, materials and heating system components

Given these constraints our recommendations for action are as follows:

TYPICAL WOOD STOVE

OLDER TYPE WOOD STOVE (POST OFFICE)

- The first type of improvement should be to upgrade existing housing to a higher level of airtightness and insulation. This can be done by a simple program of door and window weatherstripping, caulking and sealing around window casements, baseboards, etc., and upgrading the attic insulation or wall insulation in homes which have good vapour barriers. In addition, a standard set of window sizes should be established for the community's homes so that standard screen, glass, sash and hardware parts could be stocked in the community for quick replacement or repair as windows become damaged.

- The second action should focus on a natural ventilation system. This system needs to be designed, demonstrated and implemented as new construction approaches a higher degree of airtightness.

- Third, all new homes should be built to The Arctic Housing Standard in order to reduce energy consumption and improve comfort levels.

- Fourth, a regular maintenance program for stoves and chimneys should be implemented and an inventory of replacement parts should be maintained. Also, central wood furnaces or airtight wood stoves with catalytic combustors should be used in all new homes.

- The final recommendation is that training should be implemented to educate the con-

struction crew on proper installation of doors, installation of weatherstripping, and door latch setting for proper closing and tightness. Additionally, the construction crew should be trained to install doors and windows with an air-tight seal between the frame and the rough opening behind the wood casing. Homeowner's should be shown alternative techniques to cover their windows with plastic during the winter. An interior application of window plastic would prolong the life of the window frames.

4.0 Work Task III

4.1 Alternate Energy

A number of alternate energy sources were analyzed with regard to their potential application in Fond-Du-Lac. The terms of reference of this study required the consultant to examine alternatives which are applicable to houses in the community.

As a starting point community energy needs were reviewed (see Table 1) and what is apparent is that wood is the prime heating fuel in houses.

TABLE I
ENERGY USE IN FOND-DU-LAC
(Not including gas for vehicles)

	Electricity Use %	Fuel Oil Use %	Total Energy %
Education (including teacherages)	11	27	18
RCMP	1	.3	1
Communications	19	0	10
Community Buildings	13	10	12
Commercial	8	62	35
Residential	48	.7	24
	100	100	100

Source: Remote Saskatchewan Community Energy Overview Study Energy, Mines and Resources Canada, March, 1983.

Therefore, the short term option for heating homes in Fond-Du-Lac is wood. Given the low cost and ready availability of this fuel, the use of this fuel will likely continue for some time. But, there are ways in which the homeowners could reduce the amount of wood they are using and possibly produce a more even heat in the home. This could be done by installing more energy efficient stoves.

Over the longer term it is likely that residents of the community will desire to have a greater electrical capacity to solve their needs. This capacity will need to be cost-effective and manageable by the community. Options which

require substantial management time and highly specialized technical knowledge are likely not the best choice. Simple solutions are necessary and in this regard it is likely that some type of Saskatchewan Power Corporation grid connection is preferential.

5.0 Work Task IV

5.1 Community Workshops

During the week of September 9, 1984 Eneraction delivered a workshop to representatives of the community - the chief and band council. Slides and graphics were used to communicate the topics covered on the agenda. The presentation covered general techniques required to improve home comfort and increase the life of the buildings; and, the presentation demonstrated techniques necessary to improve wood heating performance and reduce the risk of fires.

5.2. Retrofit Workshop

This workshop was conducted, with the construction crew participating, in a house which required specified retrofit measures. Through demonstration on the house itself, various retrofit procedures and materials were used.

5.3 Community Work Force

The construction crew has the required skills to build houses but are not generally aware of the rationale or

techniques required to achieve energy conservation in new or existing houses. The Community Handbook (Appendix VI) describes what the crews should know and outlines what was discussed during the workshops. Generally, the crews (of which only some spoke English) were moderately enthusiastic towards the workshop presentations.

6.0 Community Energy Plan

Fond-Du-Lac can improve the quality of its housing and reduce its energy costs by pursuing the following plan of action.

6.1 The Problems

Generally the problems fit within several categories. These are:

- The homes have not been built to standards needed to cope with the Northern Saskatchewan climates and new homes are still not being built to the proposed Arctic Housing Standards.

- Existing homes have not been maintained to ensure a comfortable, minimum energy use environment and need a basic level of upgrading.

- Wood stove technology is outdated and the lack of chimney cleaning poses a fire hazard to many home-owners.

- The knowledge level of the local construction crew is not adequate to properly apply techniques to upgrade housing to higher energy standards.

A detailed analysis of the housing stock may be found in Appendix V of this report.

6.2 The Solutions

With regard to new homes being built, the community should take two steps namely:

- Require that all new housing be built to the proposed Arctic Housing Standards.
- Ensure that all new homes have either a central wood furnace or an airtight wood stove installed.

The Community Handbook (Appendix IV) contains details of the construction techniques necessary to build homes to the higher energy standard.

Practical Problem

A real problem for the community is the conflict between a limited budget for new housing and the goal of providing more new houses. This problem, in the short term, is made worse by adopting The Arctic Standards as these standards require extra funds per home.

Eneraction's estimate is that to go from current specifications to the Arctic Standards will increase the capital cost of each home by about fifteen percent. With limited budgets, the band may have to make a difficult choice - build more houses to the old standards or fewer homes with the Arctic Standards.

All of the work to be performed is relatively straight forward and can be carried out by people within the community. No special tools would be needed.

With regard to existing homes there are a number of possible sources of funding which the band could take advantage of to upgrade their homes. These are:

Canadian Home Insulation Program (CHIP)
This program is operated by the Federal Department of Energy, Mines and Resources and has the following features:

- Only homes built before 1977 are eligible.
- No work can begin on any home until approval is given by CHIP.
- CHIP only pays for work when it receives an invoice.
- CHIP only pays 33 1/3% of the cost of materials and labour up to a maximum of $500. per home.
- The materials CHIP will pay for include insulation, weatherstripping, caulking, vapour barriers.
- CHIP will only pay for labour if this labour has been trained by CGSB.
- This program can be used in conjunction with other programs.
- All work must be done by March 31, 1986.
- contact person is Wendy Jenkins, 359-6164 (Regina.).

Residential Rehabilitation Assistance Program (RRAP)

This program is administered by CMHC and has these features:

- Each home can receive a grant up to a maximum of $6,250. and loan of $10,000.
- Each home must have been built before 1980.
- The band is only required to provide funding whenever the cost of materials and labour exceeds $6,250.00 per home.
- Energy conservation items by themselves are NOT eligible but they can be included if other things are done on the house (siding, roof, windows, etc.).
- RRAP prefers to have no more than 10 homes per band being worked on at the same time.
- There are a number of details to the program which would require discussions with RRAP people before proceeding.
- The key contact person is Mr. Gil Snider, 975-4836 (Saskatoon).

Enerwise Program

This program is operated by Saskatchewan Power and has the following features:

- All residential and community buildings in the province are eligible.
- This program provides a loan of up to $3,000. per home.
- The interest rate on the loan is 8% per year and it must be repaid within 5 years.
- The loan can be used to pay for insulation, doors, windows, etc.
- The program can be used in conjunction with the CHIP program.
- The contact person is Al Markel, 566-3191 (Regina).

Renovations Program -- INAC

This program is operated by the Federal Department of Indian and Northern Affairs and has the following features:

- It offers a $6,000 grant for homes being renovated.
- The amount of funds available for each community is related to community needs and availability of departmental funds.

- This program can be used in conjunction with RRAP funds.

- Contact person is Bert Stuckless, 359-6409 (Regina).

There appears to be ample programs available for the community to upgrade their housing. Combining several programs together would enable the community to obtain about $13,000. per home in grant money. This would be more than adequate to improve the energy aspects of the homes.

With regard to training programs for the construction crew, it is clear that the solutions referred to above cannot be adequately delivered if the crew is unfamiliar with the techniques required. It is also clear that the best way to train the crew is by having them work on actual houses (new and old). Therefore, a demonstration project would be of great value in training the crew and demonstrating to the community the benefits of energy upgrading.

A Special Concern

Eneraction has a concern with the implementation of the Arctic Standards as it relates to the airtightness of new homes. Many existing homes have high humidity levels and this problem will become more severe as the new homes are made airtight. The solution in Southern Saskatchewan is to install mechanical fans or heat recovery ventilators to get rid of this humidity. Unfortunately, the electrical costs in Fond-du-Lac are too high to use these southern solutions.

Therefore, a new solution which uses controlled mechanical ventilation is needed. Unfortunately, there are no off-the-shelf designs available.

6.3 Implementation Timetable

Eneraction's recommendations are as follows:

1985 (Start Dates)

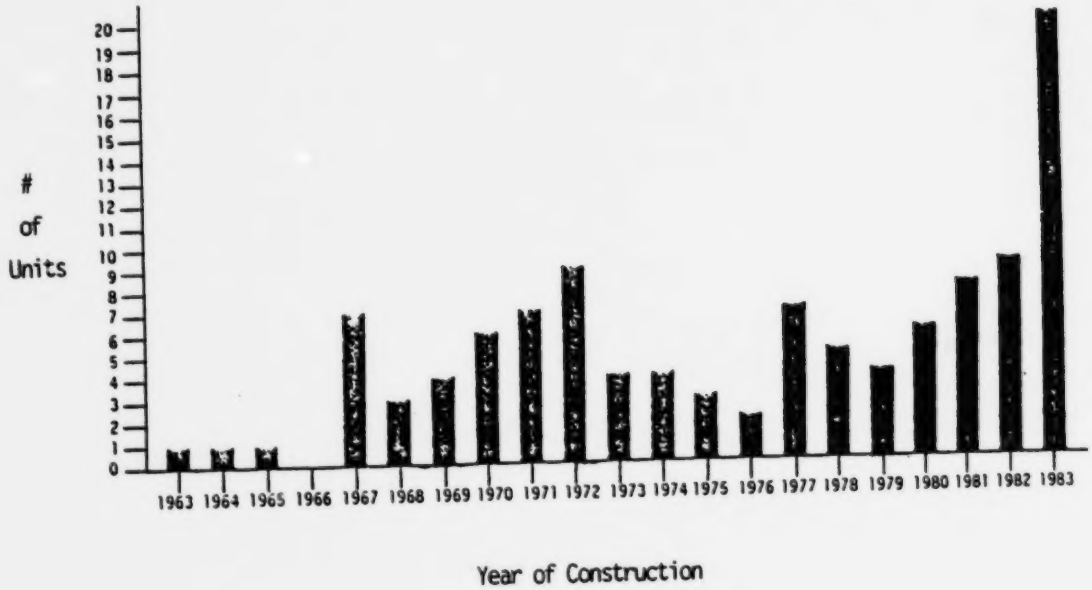
Recommendations	J	F	M	A	M	J	J	A	S	O	N	D
1. Adopt Arctic Housing Standards/Wood Stove Standard	•											
2. Build Homes to New Standard					•							
3. Training Program Starts					•							
4. Submission to RCDP For Demonstration Project	•											
5. Submission to RCDP on ventilation design	•											
6. Chimney Cleaning Program Established				•								
7. Retrofit Demonstration Program					•							

This proposed program will ensure that work on the community's housing will begin in 1985.

APPENDIX I

NUMBER OF HOUSING UNITS IN FOND-DU-LAC

(catagorized by year of construction)



APPENDIX II

LIST OF FIFTEEN HOUSES SURVEYED FROM MAY 28-30, 1984

YEARS CONSTRUCTED	OCCUPANT	HOUSE SIZE
1964	George Mercredi	24' x 24'
1967	Daniel Mercredi	24' x 36'
1967	Andrew Mercredi	24' x 28'
1970	Willie John Laurent	24' x 44'
1971	Eli Adam	24' x 32'
1972	Germain Adam	24' x 32'
1973	Jimi Fern	24' x 32'
1974	Noey Izadore	24' x 32'
1976	Maglor McDonald	24' x 32'
1977	Fredi Medal	24' x 24'
1978	Peter Fern	24' x 24'
1981	Albert Adam	24' x 32'
1982	Napolean McDonald	24' x 32'
1983	Donald Duronger	24' x 32'
1983	Toby Randall (½ Basement)	24' x 36'

APPENDIX III

CHECKLIST

FOND DU LAC

HOME ENERGY SURVEY

OCCUPANT _____

HOUSE LOCATION _____

NUMBER OF OCCUPANTS _____

YEAR CONSTRUCTED _____

HEAT SUPPLY

WOOD STOVE/FURNACE ☐

OIL STOVE/FURNACE ☐

OTHER _____

HOT WATER SUPPLY

FUEL USED TO HEAT WATER _____

WATER HEATED ON STOVE ☐

WATER HEATED IN CENTRAL HEATER ☐

FUEL SUPPLY

	YEARLY AMOUNT OF FUEL USED		COST OF FUEL
WOOD	_____	CORDS	$ _____
OIL	_____	GALLONS	$ _____
OTHER	_____		$ _____

THERMOSTAT

NONE ☐ MANUAL (ON STOVE) ☐

WALL MOUNTED AUTOMATIC ☐ NIGHT SETBACK ☐

EXHAUST FANS

HOW MANY EXHAUST FANS? _____

DO THEY LEAK WATER? YES ☐ NO ☐

DO THEY LEAK COLD AIR? YES ☐ NO ☐

HEATING SYSTEM MAINTENANCE

HOW OFTEN ARE STOVE PIPES, CHIMNEYS CLEANED? _____

FURNACE FILTER CLEANED? _____

FANS AND MOTORS INSPECTED? _____

DO ANY HOT WATER TAPS LEAK? YES ☐ NO ☐

PROBLEMS

DESCRIBE ANY OF THE FOLLOWING PROBLEMS AND WHERE THEY ARE LOCATED IN THE HOUSE.

- WATER OR ICE ON WALLS, CEILINGS, FLOORS OR WINDOWS? WHEN?

_____

_____

_____

- WATER LEAKING FROM WALLS OR CEILING? WHEN? WHERE?

_____

_____

_____

- COLD AIR LEAKS? WHERE?

_____

_____

_____

- DOES HOUSE OVERHEAT? WHEN?

_____

_____

_____

- IS HOUSE COLD OR COMFORTABLE IN WINTER?

_____

_____

_____

- IS THE AIR QUALITY

FRESH ☐
STALE ☐
HUMID ☐

- DO OUTSIDE DOORS AND WINDOWS CLOSE TIGHT?

_____

_____

- OTHER PROBLEMS OR COMMENTS?

_____

_____

_____

CONSTRUCTION MATERIALS

FOUNDATION

WOOD GRADE BEAM ☐
CONCRETE GRADE BEAM ☐
WOOD BASEMENT ☐
CONCRETE BASEMENT ☐
OTHER _____

WALLS	TYPE OF INSULATION	THICKNESS OR R VALUE
2 x 4 ☐	_____	_____
2 x 6 ☐	_____	_____
OTHER _____	_____	_____

EXTERIOR SIDING MATERIAL _____

INTERIOR WALL MATERIAL _____

FLOOR CONSTRUCTION _____

_____

ATTIC	TYPE OF INSULATION	THICKNESS OR R VALUE
TRUSS RAFTERS	_____	_____
STICK FRAMED	_____	_____
OTHER _____	_____	_____

ROOF VENTS ☐
GABLE VENTS ☐
SOFFIT VENTS ☐

OUTSIDE DOORS

WOOD, NO INSULATION ☐
METAL, INSULATED ☐
OTHER _____
STORM DOOR YES ☐ NO ☐

DOOR WEATHERSTRIPPING

GOOD CONDITION ☐
POOR CONDITION ☐
NONE PRESENT ☐

WINDOWS

WOOD FRAME ☐ SLIDE TO OPEN ☐
METAL FRAME ☐ SWING TO OPEN ☐
NUMBER OF GLAZINGS _____

CONDITION OF WINDOWS
POOR CONDITION ☐ GOOD CONDITION ☐

WINDOW WEATHERSTRIPPING

GOOD CONDITION ☐
POOR CONDITION ☐
NONE PRESENT ☐

BASEBOARDS, WINDOW AND DOOR CASINGS

NONE PRESENT ☐
POOR FIT ☐
GOOD FIT ☐

MEASUREMENT SECTION

Please record measurements in feet.

- CEILING AREA ____l x ____w =
- FLOOR AREA ____l x ____w =
- WALL AREA (include windows & doors)

  N ____l x ____h =

  E ____l x ____h =

  S ____l x ____h =

  W ____l x ____h =

- DOORS

  ____l x ____w x No. of Doors ____ =

- FLOOR JOIST HEADER

  ____l x ____w =

- BASEMENT OR CRAWL SPACE WALLS ABOVE GROUND (INCLUDE WINDOWS)

  N ____l x ____h =

  E ____l x ____h =

  S ____l x ____h =

  W ____l x ____h =

- BASEMENT OR CRAWLSPACE WALLS BELOW GROUND

  N ____l x ____h =

  E ____l x ____h =

  S ____l x ____h =

  W ____l x ____h =

- BASEMENT OR CRAWLSPACE FLOOR

  ____l x ____w =

Ft^2 Area	Type Of Insulation	Quality Of Insulation	R Value

WINDOW DIMENSIONS

Direction	Measurement (____l x ____w)	# Of Glazings	Width Of Airspace	Ft^3 Area
North				
South				
East				
West				

INFILTRATION/AIR LEAKAGE

HOUSE VOLUME

____l x ____w x ____h = _____ Volume

TYPE OF VAPOR BARRIER

- NONE PRESENT ☐
- STANDARD 2 MIL PLASTIC ☐
- 4 OR 6 MIL PLASTIC ☐
- CAULKED OR SEALED ☐

ESTIMATE OF AIR LEAKAGE RATE

VERY LEAKY _____ VERY TIGHT

FLOOR PLAN

Sketch a floor plan on the reverse side of this sheet. Indicate exterior doors, windows, room layout and south direction.

APPENDIX IV

SURVEY OF 15 HOUSES IN FOND DU LAC

Summary

Number of houses surveyed:	15	
Number of occupants per house:	range:	3 to 12 people per home
	average:	7 people per home

Question, Item or Building Component	Number of Homes In Survey	Percentage of Total Homes Surveyed
1) Building Dimension in Meters		%
7.3 m x 7.3 m	3	20
7.3 m x 8.5 m	1	7
7.3 m x 9.6 m	8	53
7.3 m x 11.0 m	2	13
7.3 m x 13.4 m	1	7
2) Heating Systems		
Wood fired space heaters	13	86
Wood fired basement furnace	1	7
Oil fired space heater	1	7
3) Thermostats		
Manual thermostats working	5	33
Circulation fan working	4	27
4) Stovepipes		
Cleaned periodically	6	40
Never cleaned	6	40
Not yet cleaned since new construction	3	20
5) Cooking and Water Heating		
110 volt two burner stove and oven	13	86
Kerosene camp stove	1	7
Wood fired stove and oven	1	7

Question, Item or Building Component	Number of Homes In Survey	Percentage of Total Homes Surveyed
6) Inside Ice During Winter		%
on ceilings	7	47
on floors	8	53
on walls	12	80
on windows	13	86
7) Occupants Assessment of Air Leakage		
minimal leakage	2	13
door and window leakage	11	74
leakage 'everywhere'	2	13
8) Occupants Assessment of Overheating		
due to wood stove	9	60
during summer heat	10	67
9) Occupants Assessment of Air Quality		
air quality fresh	13	86
air quality stale	0	0
air quality humid	2	13
10) Occupants Assessment of Comfort		
home considered comfortable	9	60
home considered not comfortable	6	40
11) Foundation		
concrete grade beam	13	87
wood foundation wall	2	13
wood basement	1	7
12) Floors - 38 x 185 mm (2" x 8") With Thermal Resistance		
RSI 0	1	7
RSI 1.4	2	13
RSI 2.1	8	53
RSI 3.5	4	27

Question, Item or Building Component	Number of Homes In Survey	Percentage of Total Homes Surveyed
13) Above Grade Walls - 38 x 89 mm (2" x 4")		%
construction with:		
RSI 0	1	7
RSI 1.4	2	13
RSI 2.1	8	53
- 38 x 140 mm (2" x 6")		
construction with:		
RSI 3.5	4	27
14) Finishing Materials		
Hardboard prefinished exterior siding	15	100
Plywood or panel board interior finish	12	80
Gypsum board interior wall and ceiling finish	3	20
15) Roof and Attic Insulation		
Premanufactured roof trusses with 1 to 3 pitch, asphalt shingles and gable vents	15	100
Attic insulation to: RSI 0	1	7
RSI 8	3	20
RSI 12	9	59
RSI 40	1	7
RSI 60	1	7
16) Main Exterior Door		
Uninsulated solid core doors	13	86
Uninsulated hollow core doors	1	7
Insulated metal doors	1	7
Doors with good weatherstripping	1	7
Doors with fur or rug weatherstrip.	4	27
Doors with no weatherstripping	10	67
Homes with screen or storm doors	11	73
Homes with exterior porches	9	60

Question, Item or Building Component	Number of Homes In Survey	Percentage of Total Homes Surveyed
		%
17) Windows		
Wood casement opening windows	7	47
Wood sliding opening windows	3	20
Vinyl sliding opening windows	5	33
Homes with one or more single glazed windows	6	40
Homes with double glazed windows throughout	9	60
Homes with weatherstripping on all windows	5	33
Homes without weatherstripping on some windows	10	67
Homes with all windows in good condition	8	53
Homes with some or all windows in poor condition	7	47
17) Baseboards, Door and Window Casings		
Homes without baseboards, door or or window casings	1	7
Homes with poor fitting baseboards, door or window casings	8	53
19) Vapour Barrier		
No vapour barrier observed in some area of the house	5	33
2 mil or paper back insulation assumed on all floors, wall ceilings	9	60
4 mil vapour barrier observed	1	7

APPENDIX V
HOUSING STOCK ANALYSIS

PREFACE

The original work statement required that the retrofit strategies suggested for Fond du Lac be based on The Arctic Housing Standard and that various retrofit recommendations be analyzed for five, ten and fifteen year paybacks. This cost payback analysis is not possible for two reasons; first, the major energy supply for residential space heating is wood, which is obtained at no direct cost, by the home occupants from the forest. Second, the housing stock is generally in such poor condition that basic improvements are required to improve living conditions, and to increase the life span of the housing stock.

The Fond du Lac climate is severe, even by south Saskatchewan standards, with a heating season of approximately 7860 Celsius degree days, and a 5% January design temperature of -39^{o}C.

The Artic Building Standard

The Arctic Building Standard requires insulation and airtightness levels significantly beyond any conditions which currently exist in Fond du Lac. Examples of these requirements for an 8000 Celsius degree day climate are:

- mimimum suggested thermal (heat) resistance for buildings more than 250 mm above ground: RSI 6.22
- mimimum suggested thermal resistance for foundation wall assemblies up to 250 mm above ground: RSI 1.75
- mimimum suggested thermal resistance for foundation wall assemblies greater than 250 mm above ground: RSI 17.7
- air-vapor barriers are to be sealed in conformance with the pertinent subsection 26 in The Arctic Building Standard, which requires a high degree of airtightness maintained with thick plastic sheeting, and rigidly specified caulking and sealing requirements.
- mechanical ventilation is required with an airtight air-vapor barrier, or in certain instances as described in subsection 33, natural ventilation is allowed to provide the necessary air change for the home.

Work Task II - Item 2.3.1 a) b) c)

The housing stock in Fond du Lac is rudimentary and provides only basic shelter to its occupants, with few amenities beyond the bare essentials.

There are presently 111 homes in the community, all of which have been constructed since 1964. The homes are situated on a site sloping south, positioned in an irregular pattern across the sandy, tree-cleared community. Sewer and water services are not available and electricity is limited in capacity, providing only 110 volt service to residential homes.

The houses are all bungalows, typically 7.3 m wide by 9.8 m long (24' x 32'). The house styles, building techniques and construction materials have not varied substantially from year to year, although the 43 homes constructed since 1980 have introduced some new concepts as outlined below. The condition of the housing stock does vary greatly depending on occupant maintenance and year of construction.

A sample of 15 homes was surveyed during May of 1984, as described in Progress Report #1. The sample was selected to represent different home sizes, different years of construction and different building technologies. A summary of the data obtained from this survey can be found in the appendix. A discussion of this data and the observations recorded during the community visit are outlined below.

a) Foundations and Floors

Foundations are typically 200 x 600 mm (8" x 24") concrete grade beams on 200 x 400 mm (8" x 16") footings. The foundation is typically dug about 300 mm into the sandy grade, leaving 300 mm bare concrete exposed above grade. The grade level varies greatly from house to house, with some foundations buried below the first floor level, and other foundations exposed to below the footings. These foundations provide

a crawlspace below the floor of approximately 600 to 800 mm in height. The crawlspace is typically vented with two open vent holes through the foundation wall.

Floors over the crawlspace are constructed with 38 x 185 mm joists (2" x 8") with insulation values of RSI 1.4, 2.1 or 3.5 (R 8, 12 or 20). The insulation is secured in place, between the joists with a plywood 'insulation floor', set horizontally in the joist space at the appropriate depth to accommodate the insulation thickness. Insulation is not present on any of the concrete grade beam foundation walls.

The sample survey included two homes constructed in 1983. One of these homes was built on a 600 mm (24") wood foundation wall and the other on ½ wood foundation wall and ½ wood basement. The home set on the full wood foundation wall was set so deep below grade that the land sloped toward the house on two sides with exterior wall siding buried below grade. Crawlspace vents were situated below grade and general site drainage was directed towards the vent openings. It's not known if insulation is in the wood foundation walls. The below grade exterior sheeting was <u>not</u> pressure treated plywood. The home constructed with ½ wood basement was also constructed <u>without</u> pressure treated plywood below grade. The home with the wood basement had insulation installed, but no vapor barrier in the full basement section. The crawlspace section of the home had neither insulation nor a vapor barrier on either the foundation wall or the floor above.

<u>Conclusions</u> Foundation walls and floors over crawlspaces are typically insulted far below The Arctic Housing Standards of RSI 6.22 for floors over an unheated crawlspace or RSI 1.75 minimum for foundation walls to 250 mm above grade. Construction procedures to erect wood foundation walls or wood basements have not been correctly applied and education of the construction crew is necessary to improve the procedures. Crawlspace venting is often larger than required and not controllable with an operable damper.

b) Above Grade Walls and Roof Structures

Walls above grade are 38 x 89 mm (2" x 4") wood studs for homes constructed previous to 1980 and 38 x 140 mm (2" x 6") wood studs for homes constructed since 1980. The insulation actually installed in the walls of the sample homes was not observed directly, but was concluded through conversation with the home occupant and/or construction crew. Insulation varied from non-existent in the walls of one older home to paper backed RSI 1.4 (R 8) in pre-1970 construction, RSI 2.1 (R 12) for construction during the 1970-1979 period and RSI 3.5 (R 20) in construction since 1980.

Exterior siding is exclusively pre-finished, hardboard, horizontal siding over plywood sheathing. Interior wall and ceiling panels are painted plywood and panel board in all houses sampled, constructed prior to 1980. The three sample houses from 1982 and 1983 construction seasons had interior ceiling and wall finishing of gyproc, which was taped, sanded and painted in one instance, and which consisted of vinyl surfaced gyproc panels in the other two homes.

All roofs are a standard 1 in 3 pitch, covered with asphalt shingles and constructed with pre-manufactured roof trusses, standard gable ends and 600 mm overhangs. Attics are vented through gable vents.

Ceiling insulation ranged from RSI 0 in the 1982 home (because insufficient insulation had been supplied) to a typical value of RSI 1.4 or RSI 2.1 in homes constructed prior to 1980, and RSI 7 in newer homes constructed since 1980.

Conclusions Insulation in all sample homes constructed prior to 1980 was RSI 2.1 or less, in both the walls and the attic. This quantity of insulation is not sufficient for this climate and far below The Arctic Standard level. The homes in the sample which were constructed since 1980 had their walls insulated to RSI 3.5 and attics to RSI 7.0, RSI 10.9, and the one 1982 house which had RSI 0 over most of the attic

space. The construction crew indicated that new homes were supposed to have attic insulation levels of RSI 7.0. Even the greater amount of insulation present in the walls of the new construction (RSI 3.5) does not meet the minimum requirement for energy efficient arctic housing. The attic insulation in new construction exceeds the proposed minimum arctic standard for this region.

c) Doors and Windows

The opening windows in the homes sampled range from single glazed, double hung windows installed during the 1960's building period, to double glazed wood casement windows during the 1970's, and double glazed vinyl sliders installed in newer homes constructed since 1980. All houses had their large fixed windows or 'picture' windows constructed with wood frames, either single or double glazed. Many windows were in very poor condition, with 7 of the 15 homes requiring major window repair or total window replacement.

The poor condition of the windows is primarily due to the high humidity/condensation which rots the wood sash and frame. Windows have typically not been repaired properly, and a broken double pane will often be replaced with a single pane. The new vinyl slider windows are notoriously bad for air leakage, although their frames will not rot. The weather-stripping present in the vinyl sliders will not last long due to the sand which blows into the sliding window channels and grinds the weatherstipping apart.

To counteract the poor window performance during winter, windows are covered with polyethelyene during the heating season. This is apparently done on all houses, new and old. The polyethelyene is attached on the exterior of the window, over the window moulding. The technically correct method of installing an extra sheet of polyethelyene would be over the interior of the window, to help decrease infiltration and eliminate condensation on the window sash and glass surface.

Exterior doors observed in the 15 homes were most often solid, wood core, uninsulated doors. Doors are typically not set square into their rough openings, with poor handle and latch settings. Ten of the homes had doors without weather-stripping, and four homes had homemade weatherstripping of fur or rug composition. One home was equipped with a metal insulated door with good quality weatherstipping, however, the latch was set very loose and consequently the weatherstripping was not in contact with the door.

No provisions were made to seal the crack between window or door frames and the rough framing opening. Window or door casings covering this crack were most often installed poorly.

Eleven homes in the survey were equipped with storm doors, all without weatherstripping. Nine homes had a makeshift porch (approximately 2 m x 2 m) outside the main entrance door. All houses in the survey were designed with two exterior entrance doors. In 6 homes, the second door was permanently sealed with insulation and plastic. In other homes, the second door was sealed during the winter heating season.

Conclusions Door and window openings are inadequately treated in all the homes surveyed. Higher quality windows and doors, equipped with proper weatherseals, should be provided for future construction and retrofit to existing dwellings as necessary. A standard set of window dimensions should be established for the community's homes, so that standard screen, glass, sash and hardware parts could be stocked in the community for quick replacement or repair as windows become damaged.

Training should be implemented to educate the construction crew on proper installation of doors, installation of weather-stripping, and door latch setting for proper closing and, tightness. Additionally, the construction crew should be trained to install doors and windows with an airtight seal between the frame and the rough opening behind the wood casing. Homeowners should be shown alternative techniques to cover their windows with plastic during the winter. An interior

application of window plastic would prolong the life of the window frames.

d) Air-Vapour Barriers, Moisture Damage and Airtightness

Air leakage was obviously high in all the houses surveyed, with condensation problems apparent in most homes. Ceiling rain was reported in 8 of the 15 homes (that is; ice which accumulates in the attic during winter and runs through the ceiling with the spring thaw). Two homes reported that ceiling light fixtures were not working, which could be the hazardous result of high attic moisture.

Ice deposit was reported on the windows in 13 homes and ice was reported on walls and/or floors in 12 of the 15 homes.

All homes reported the need to cover windows with plastic during the heating season.

Rust was observed on finishing nails and screws on interior walls and ceilings in most of the homes.

The plywood and panel board interior wall and ceiling boards in pre-1980 houses appeared to be structurally sound in spite of the constant wet/dry cycle from season to season. The vinyl gyproc board in the 1982 and 1983 homes already shows signs of deterioration due to water damage.

The actual placement of a vapor barrier in walls, ceilings or floors could not be directly observed. However, the effects of airtightness and vapor control could be observed and consistently indicated an extremely leaky structure.

Conclusion Air leakage in these homes is extremely high and is causing rapid structural deterioration and discomfort to the occupants. The technical relationships between air-vapour barrier and insulation does not appear to be understood by the occupants or the construction crew. Homes built prior to 1980 suffer more from poor insulation and high air leakage, but are less susceptible to the wet/dry cycle because of the

wood panel and plywood interiors from which they were constructed. Homes built since 1980, with greater amounts of insulation, interior finishes of gyproc material, and wood foundations, will deteriorate much more rapidly if improved air-vapour barriers are not installed.

In order for the housing stock to improve, especially with regard to the new materials and insulation levels now in use, it is necessary to educate the construction crew about airtight building techniques and emphasize the importance of maintaining a high quality control procedure with regard to airtightness.

e) Heating

Heating was accomplished with a wood fired space heater in 13 of the 15 homes. One of the remaining homes was heated with an oil space heater and the other with a wood fired central furnace located in the basement. Chimneys in all homes were double walled metal chimneys suspended from the roof trusses.

Most heating systems observed were in poor repair. Only five of the fifteen homes surveyed had a functioning manual thermostat, and only four homes had an operational air circulation fan on the wood or oil stove. The wood furnace in the 1983 home was poorly installed and was not well understood by the home occupant.

In the 12 homes constructed prior to 1980, 6 occupants had never cleaned the stovepipes or chimneys, and the remaining six occupants cleaned pipes and chimneys at least once per year.

The three occupants of the homes constructed in 1982 and 1983 had not yet cleaned the chimneys or stovepipes.

The amount of oil consumed in the oil space heater was 3050 liters at a total cost of approximately $1,500.00 for one year of operation.

The amount of wood consumed for space heating was not known by six home occupants. Eight occupants estimated annual wood consumption at between 9 and 40 cords of wood per year. The average estimated consumption was 12.5 cords per year (45 cubic meters).

Wood is not typically stock piled by the home occupant for a whole heating season. Wood stockpiles apparently last until about December, after which time wood is gathered from the forest, with a snowmobile and sleigh as needed. A mixture of greenwood and drywood is typically used to control the heat output of the wood stoves.

Nine occupants reported poor temperature control with their stoves, and that their homes often overheated during the winter.

Conclusions The basic stove technology used in these homes is appropriate, considering the cost of the alternative space heating fuel such as oil, and considering the abundance of local firewood. The stoves and chimneys require more regular maintenance, and a stock of replacement parts should be maintained in the community so that stoves and chimneys can be periodically inspected and repaired.

The central wood furnaces installed in the new 1983 homes will be a significant improvement to comfort due to the central forced air system and the improved burning technology. However, education of the installation crew and home occupant is necessary to ensure proper installation and maintenance.

Discussion

The previous analysis demonstrates the poor general quality of the housing stock in this community. The basic services, home sizes, building technology and comfort are below acceptable standards when compared to even the minimum requirements of the National Building Code. The gap between Fond du Lac Housing and The Arctic Building Standards is so great that immediate upgrading to these northern standards is not realistic.

The problems and constraints facing higher quality housing start with a lack of adequate resources allocated for housing, compounded by inadequate construction quality and inadequate building inspection, inappropriate building components, (such as the doors and windows described above), and the lack of skill, knowledge, and/or motivation appropriate to the task.

The severity of the climate, and the humidity from the high occupancy increases the rate of deterioration of the housing stock.

House maintenance is typically not done by the home occupant, and is therefore often not done at all. A system of standardized building components, such as standard window sash, glass and screen sizes, or a stock of replacement parts for stoves and chimneys, is not available in the community.

Improvement of the energy performance of these houses cannot be isolated from improvement to the housing stock in general. Any improvement to the housing stock or energy performance must be coordinated with existing programs of maintenance, major renovation and new construction.

Improving the residential energy standards can be accomplished by increasing the amount of insulation, improving airtightness (and providing ventilation), and improving the stove or furnace efficiency. The ultimate goal of this improvement would be to construct to the standards of The Arctic Building Code.

The task of upgrading the housing will necessarily be accomplished over a long time frame. The skills necessary to con-

struct to higher standards must be taught and demonstrated to the construction crews. The home occupants will also have to be made aware of the implications of better building systems.

The issue of airtightness and the concurrent requirement of mechanical ventilation cannot be resolved under the current circumstances.

On the one hand, the existing housing stock is deteriorating rapidly because of the lack of an air-vapour seal and the consequent water damage inside walls, ceilings, floors, doors and windows. This problem is becoming increasingly pronounced as new products (such as wood foundation walls and gypsum board interiors) are introduced.

On the other hand, the solution to the problem of deterioration presents new problems which do not have an immediate solution in the community. The introduction of an air-vapour barrier requires mechanical ventilation to control internal humidity, provide combustion air and maintain air quality. Mechanical ventilation is not realistic in the community because the current electrical system could not economically provide the power for electric ventilation fans, and because the people of the community could not be expected to operate and maintain an entirely new technology like mechanical ventilation. Natural ventilation can control air quality and humidity in an airtight structure. However, the knowledge available on natural ventilation is limited, and adapting this knowledge to the particular situation in question would require a carefully monitored program of demonstration and evaluation. This problem of providing ventilation to future airtight structures is currently unresolved.

Recommendations

Considering the existing problems and constraints, an incremental approach to the improvement of the housing stock will be necessary.

The first level of improvement will be to upgrade existing housing to a higher level of airtightness and insulation. This can be done by a simple program of door and window weatherstripping, caulking and sealing around window casements, baseboards, etc., and upgrading the attic insulation or wall insulation in secure situations.

The risk of tightening the existing houses to a dangerous level of airtightness is not a current concern, considering the very leaky condition of the homes.

The second level of energy performance improvement will focus on the construction of new housing and the major housing renovation which will be taking place in the community. A natural ventilation system will have to be investigated and demonstrated. This natural ventilation system will need to be implemented as new construction approaches a higher degree of airtightness. The insulation standards of new housing and renovation projects are currently adequate, considering that moving to The Arctic Standards will require modified wall and foundation construction, and will require more dollars per housing unit than are being allocated at this time.

The final level of home improvement will be to construct and renovate to The Arctic Housing Standards. However, significant changes will have to occur in the monetary resources and pool of skills available, before this standard of construction can take place.

The workshop on immediate new housing construction has been delivered to the construction crew, as described in Progress Report #1. The second visit to the community will take place towards the end of the summer and will concentrate on the first level of energy retrofit described above.

A proposed agenda for the community seminar and construction crew workshop is attached as an addendum to this report.

APPENDIX VI

HANDBOOK

ENERGY EFFICIENT CONSTRUCTION

AND RENOVATION TECHNIQUES,

AND WOOD HEATING SAFETY

FOR

THE COMMUNITY OF FOND-DU-LAC

PREPARED BY
ENERACTION RESOURCES INCORPORATED
REGINA, SASKATCHEWAN
OCTOBER 12, 1984

INTRODUCTION

Existing homes in Fond-Du-Lac burn 10 to 15 cords of wood each winter to maintain interior temperatures. The amount of wood burned could be reduced by more than one-half by following the techniques in this handbook.

There are two principles which must be applied to a home in order to improve its energy efficiency. These are:

1. Increased insulation levels in walls, floors, ceilings, doors and windows.
2. Increased airtightness of the building shell including walls, floors, ceilings, doors and windows.

These two principles must be applied together. Insulation should not be added without airtightness also being improved. If one of these principles is applied to a home without the other, condensation problems will result.

This handbook has three sections. The first section outlines the requirements for improved insulation and airtightness in new construction. The second section outlines techniques to improve the airtightness of an existing home before insulation is added. The third section outlines the principles of wood heating safety.

SECTION I

GUIDELINE SUMMARY FOR NEW HOME CONSTRUCTION

The following guidelines illustrate the minimum specifications and construction techniques which should be followed when constructing new housing, or completely renovating existing housing to new standards.

a) Airtightness

1) The air vapour barrier should be installed so that it provides a complete seal around the entire structure.
2) The air vapour barrier should be 0.15 mm polyethylene sheeting, caulked and sealed at all joints.
3) Caulking materials should be non-hardening and maintain flexibility when in contact with the polyethylene sheeting.
4) All joints between polyethylene sheets should be made over the top of solid backing materials.
5) The air vapour barrier should be continuous behind partitions at walls and ceilings.
6) The air vapour barrier should be sealed where it joins doors, windows, attic hatches, receptacles or similar openings which penetrate the air vapour barrier.

b) Insulation

The following insulation levels are recommended minimum standards, and reflect current building practices. Insulation values should be increased to the proposed Arctic standards over the next building seasons.

Building Assembly	R_{SI} Value	R Value
Basement walls to floor	3.5	20.0
Basement floor perimeter to 1.2 m inside foundation footings	1.3	7.5
Footing insulation to 1.2 m outside foundation wall, for foundation footings less than 1.5 m below grade	1.3	7.5
Above grade walls	3.5	20
Ceiling	7.0	40
Floors over unheated spaces	4.9	28.0
Slab on grade, perimeter insulation	3.5	20.0
Doors	1.76	10.0
Windows	Triple glazed, 13.0 mm airspace between glazings	

c) Ventilation

Airtight homes require continuous ventilation (fresh air) for comfort and humidity control. Fan operated mechanical ventilation systems are not currently possible because of inadequate electrical services.

The minimum requirement for a ventilation system without a mechanical fan is good quality opening windows which can provide fresh air through manual control.

Homes should be designed and constructed with at least one opening window on each side of the house to ensure that fresh air can be provided in any wind condition. Windows should be triple glazed. In addition, casement type, wood sash or awning windows should be vinyl or vinyl covered in order to permit free operation in all weather conditions and to avoid icing on window glass and frame surfaces. Sliding windows and double glazed windows should not be installed because they tend to freeze shut during the winter heating season.

CAUTION: With the presence of wood heaters and high home occupancy, at least one window should be open at all times to guarantee fresh air intake to the home.

d) House Siting and Window Orientation

The direction of large windows in a house influences energy performance and comfort due to the amount of sunlight which can enter in summer or winter.

1) Maximum window area should not exceed 12% of the total building area served by the window.

2) The best energy performance and passive solar gain results from major window areas facing within 30^0 east or west of south.

3) The maximum window area facing south should not exceed 8% of the above ground floor area.

4) The following table lists the roof overhang width necessary to shade south windows from summer sun, and allow winter sun penetration.

Window Depth From Bottom of Lintel		Overhang Width	
0.9 m	(3 ft)	0.6 m	(2 ft)
1.5 m	(5 ft)	0.9 m	(3 ft)
2.1 m	(6.8 ft)	1.2 m	(4 ft)

5) If major window areas face east or west, summer shade control should be provided with awnings, vegetation, reflective films or shades.

6) Major window areas should not face north.

e) Energy Conserving House Construction Practices

The following diagrams illustrate techniques for achieving airtightness and higher insulation levels in an energy conserving house. These diagrams are grouped according to each major subtrade involved in the construction of a residential structure. The drawings are from the following publications:

Air Vapour Barriers: D. Eyre, D. Jennings, Saskatchewan Research Council, 3rd Edition, March, 1982.

Energy Efficient Housing - A Prairie Approach : University of Saskatchewan Energy Research Development Group, 1980, revised 1982. Available from Alberta Energy and Natural Resources, Saskatchewan Energy and Mines, Manitoba Energy and Mines Departments.

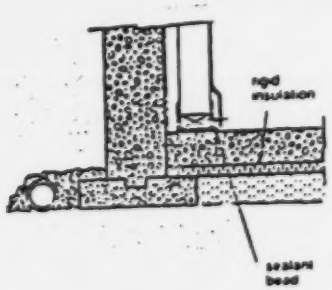
Seal Your House Before Reinsulating: 1978 (This publication is no longer available.)

The construction techniques illustrated in this HANDBOOK section do not represent all acceptable building alternatives, nor do they cover all problem areas that will be encountered during construction practice.

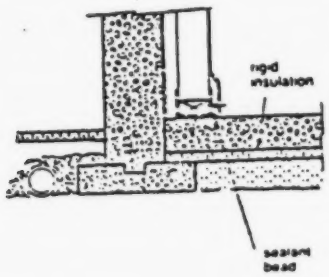
f) Basement and Floor System

1) Perimeter Insulation

The perimeter of the basement floor looses a large amount of heat over a heating season. 38mm (1.5") of rigid insulation should be applied to 1.2m (4') inside the perimeter, before pouring the basement floor slab.

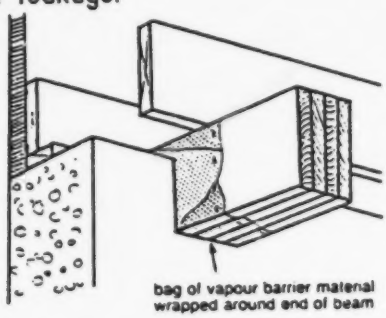


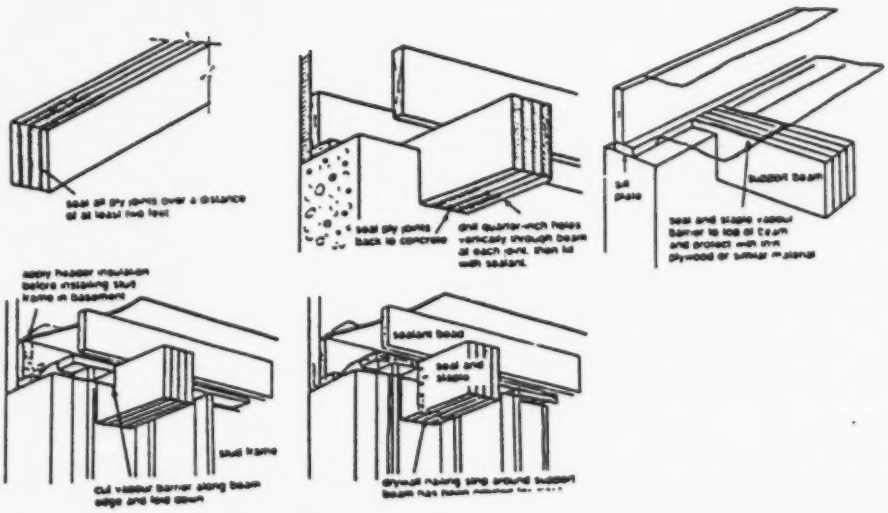
For shallow foundation footings less than 1.5m (5') below the ground surface, an additional 38mm (1.5") of rigid insulation should be applied outside the foundation wall, above the footings to a distance of 1.2m (4') from the foundation wall.



2) Floor Support Beams

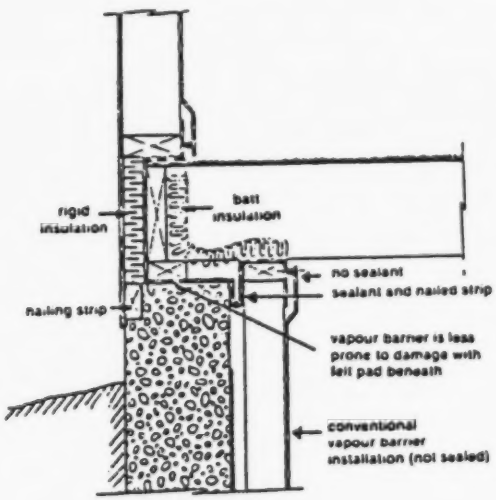
The area where the beam penetrates the wood or concrete wall creates a path for air leakage. The accompanying diagrams illustrate two different techniques to seal the beam against air leakage.

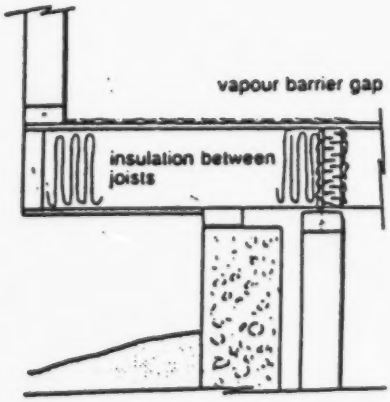


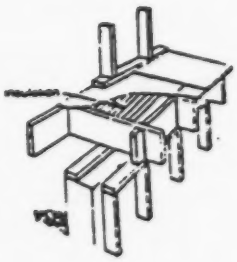


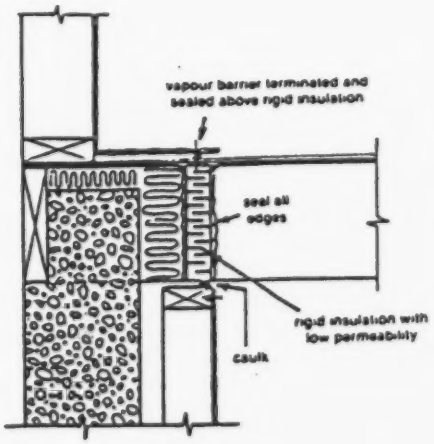
3) Airtightness and Insulation of Floor Systems

The exposed floor header and joist system is a common area of air infiltration. The accompanying diagrams illustrate the techniques of wrapping a continuous air vapour barrier around the floor system and, at the same time, maintaining adequate insulation levels.


rigid insulation
batt insulation
no sealant
sealant and nailed strip
nailing strip
vapour barrier is less prone to damage with felt pad beneath
conventional vapour barrier installation (not sealed)



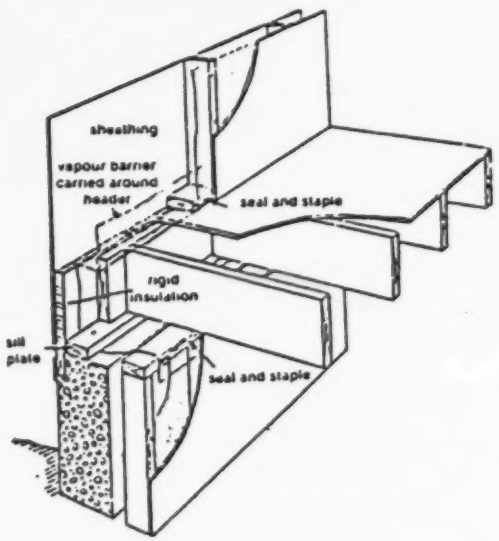


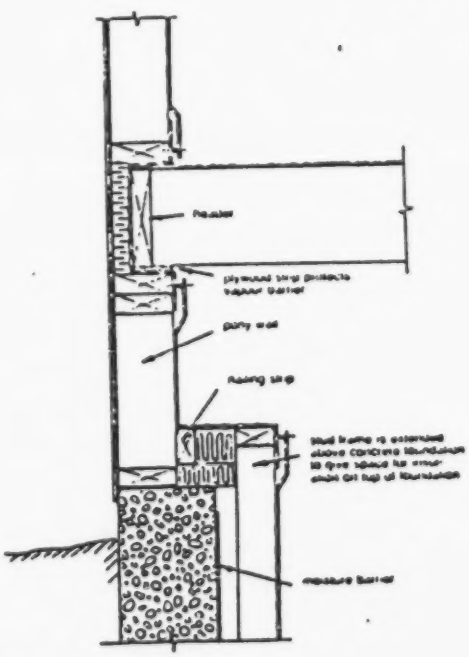

vapour barrier terminated and sealed above rigid insulation
seal all edges
rigid insulation with low permeability
caulk

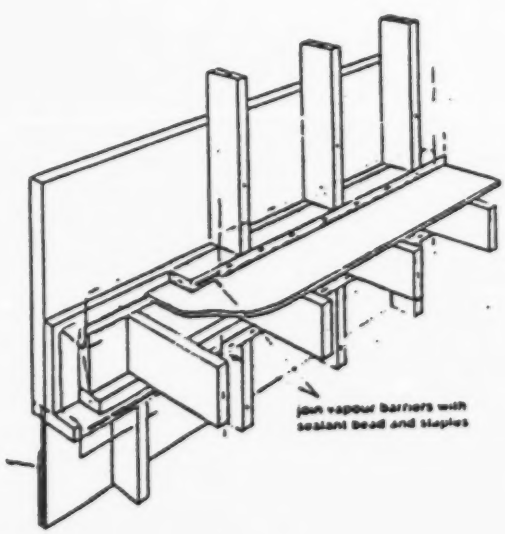
g) Framing

1) Exterior Wall Sill Plates and Floor Systems

Exterior walls should be placed carefully on top of the plastic wrapped around the floor header system. The same techniques apply to first and second wall/ floor joints and to pony walls.

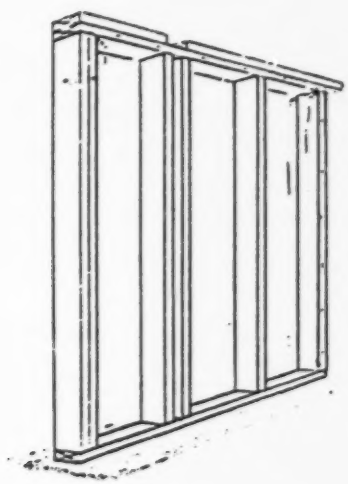


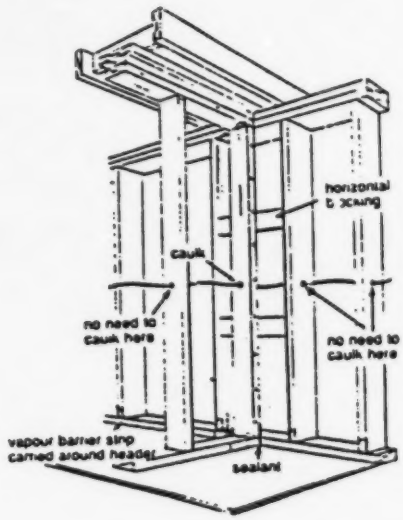


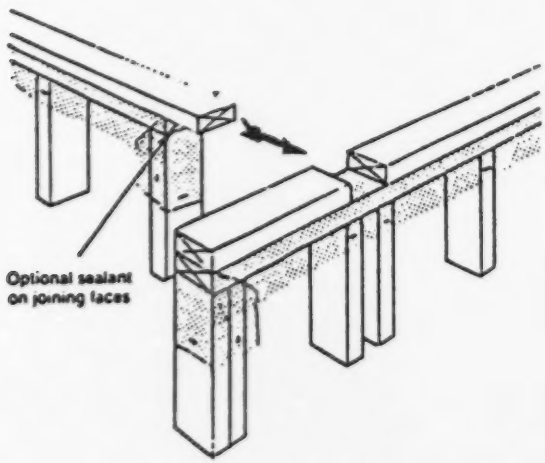


2) Polyethylene Strips on Exterior Paritions

In order for the air vapour barrier to be continuous, strips of 0.15 mm (6 mil) polyethylene must be applied behind all exterior wall and ceiling partitions. Care should be exercised so that these strips are not damaged during construction.



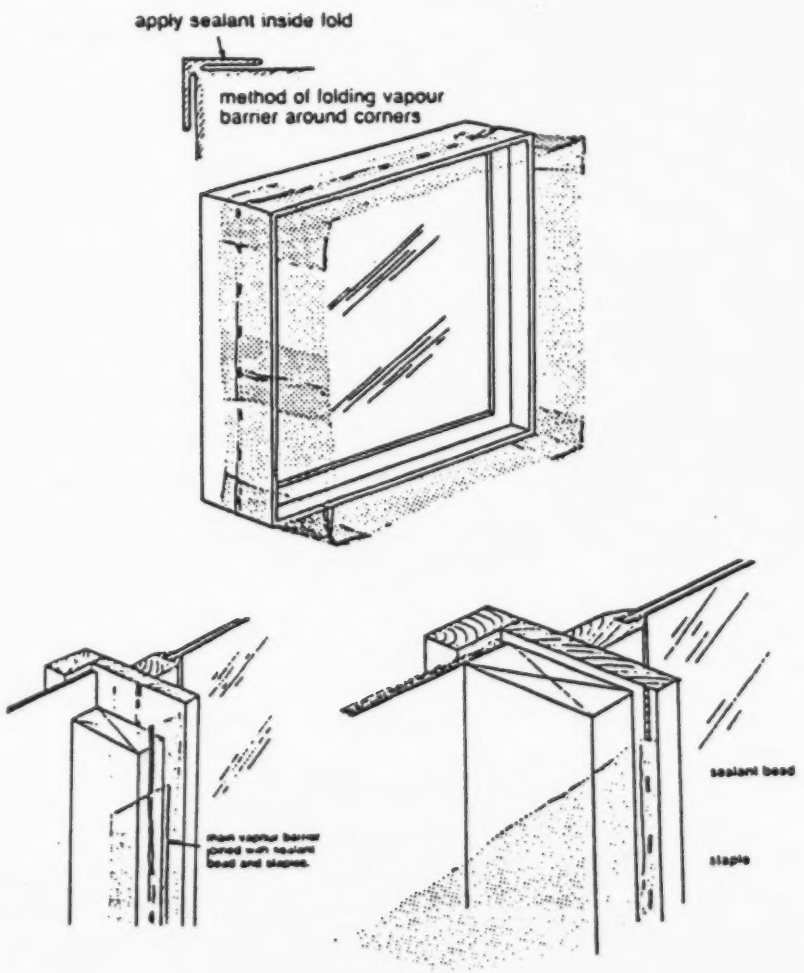




3) Door and Window Preparation

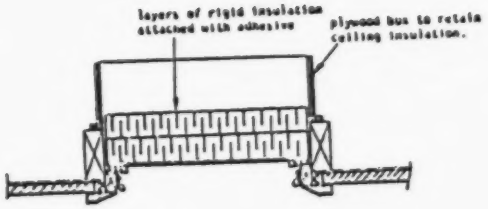
Both doors and windows can be prepared before installation, so that airtightness can be maintained between the frame and the rough opening. A 0.15 mm (6 mil) strip of polyethylene should be caulked and stapled to the window. Folds should be left at the corners in order to allow the plastic to fold around the rough opening without tearing or cutting.

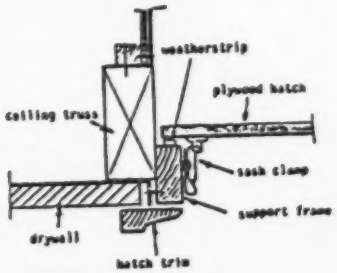
Another technique is to seal the final vapour barrier against the window frame after installation of the window is complete.

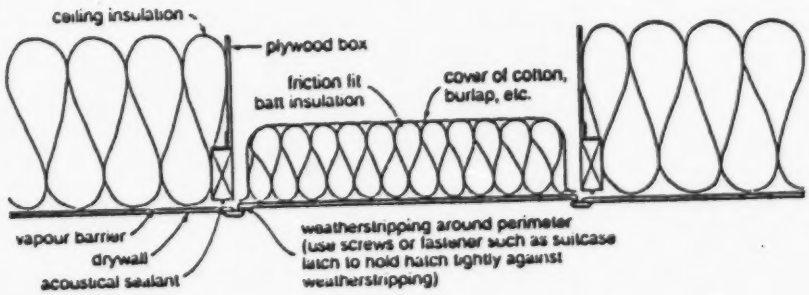


4) Attic Hatch

The attic hatch should be moved to the exterior gable above the ceiling insulation, or constructed as demonstrated with the accompanying diagrams.

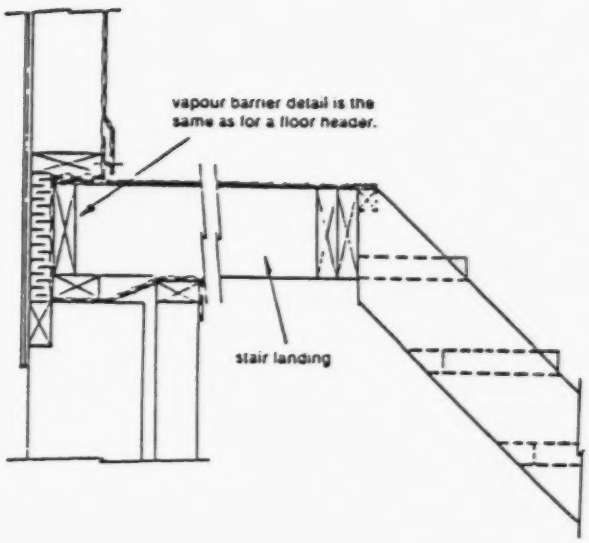


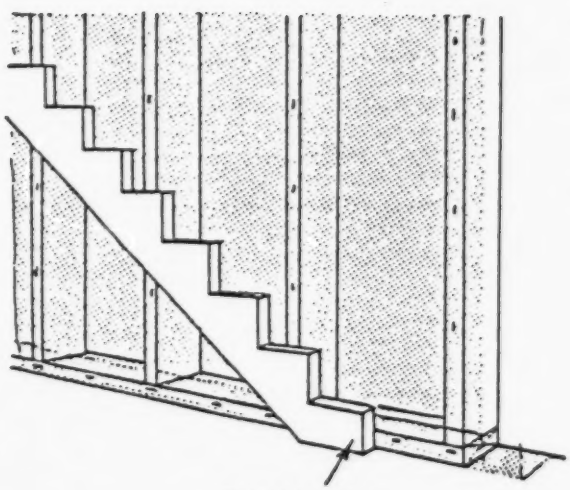



ceiling insulation
plywood box
friction fit batt insulation
cover of cotton, burlap, etc.
vapour barrier
drywall
acoustical sealant
weatherstripping around perimeter (use screws or fastener such as suitcase latch to hold hatch tightly against weatherstripping)

5) Stairs Next to Exterior Walls

Where stairs are next to exterior walls, care must be taken so that the air-vapour barrier, insulation and drywall are fully installed before final installation of the stair system.





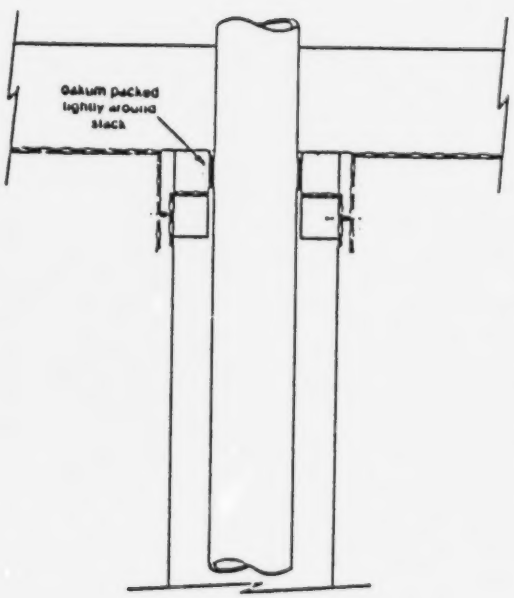
6) Blocking

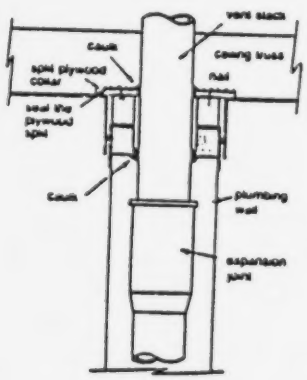
All blocking for cabinets, towel bars, soap dishes and drywall application should be in place prior to installation of the air vapour barrier.

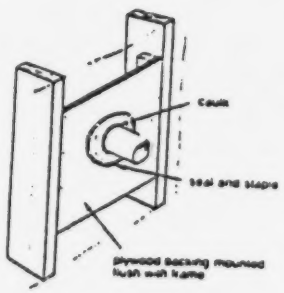
H) Plumbing

1) Stacks and Vents

All plumbing stacks and vents should penetrate the air vapour barrier envelope through round holes in solid backing materials and be sealed with caulking against air infiltration. If available, rubber "boots" should be used in preference over caulking.

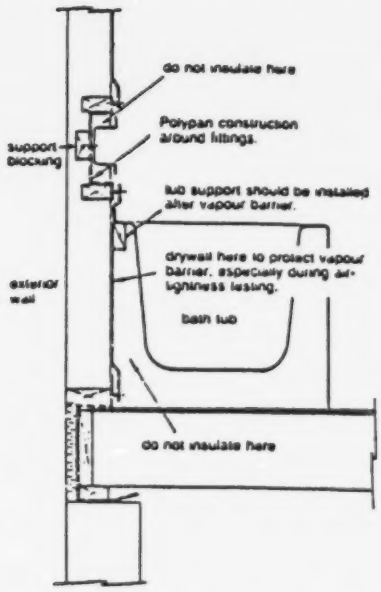






2) Tubs and Shower Enclosures

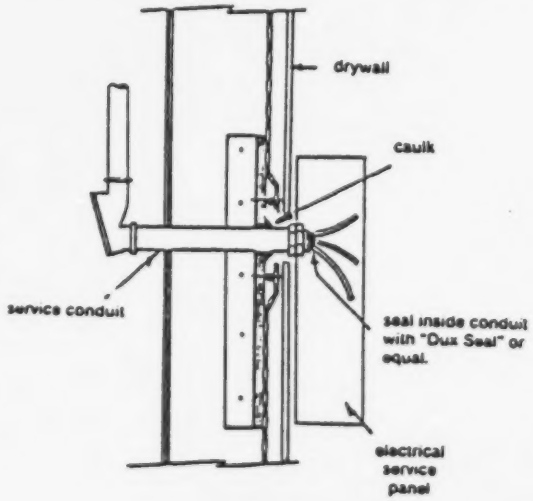
Exterior walls adjacent to tubs and showers should be prepared with insulation and air-vapour barriers before final application of the tub or shower enclosure. Appropriate right or left hand tubs should be chosen to keep water piping away from exterior walls. Where possible, soap dishes should not be placed in exterior walls.


do not insulate here
Polypan construction around fittings.
support blocking
tub support should be installed after vapour barrier.
drywall here to protect vapour barrier, especially during air-tightness testing.
exterior wall
bath tub
do not insulate here

I Electrical

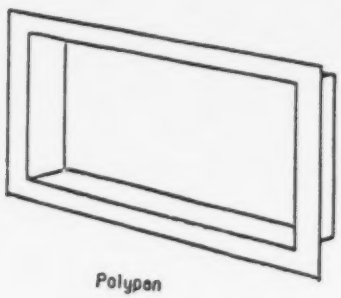
1) Electrical Service Panels

Electric service panels should be installed on interior partition walls where possible, to avoid puncturing the air-vapour barrier with wire runs. Where the service panel must be applied to an exterior wall, the insulation, air-vapour barrier and drywall should be properly placed first.

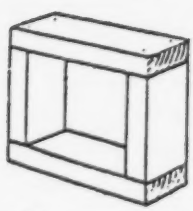


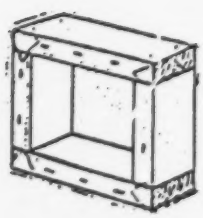
2) Exterior Wall Receptables

Receptacles must be placed inside appropriate "polypans" or "polyhats" before fixing to wall studs or wiring. In order to insure airtightness around electrical outlets.

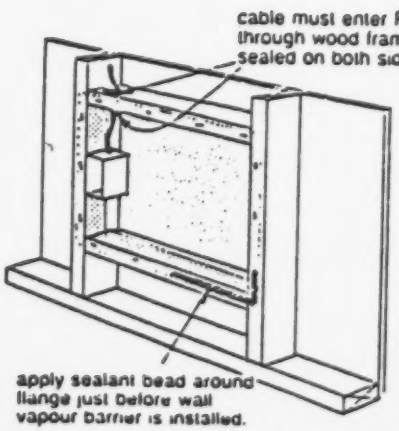


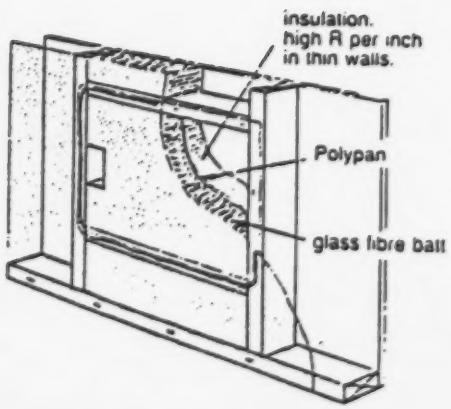
Polypan





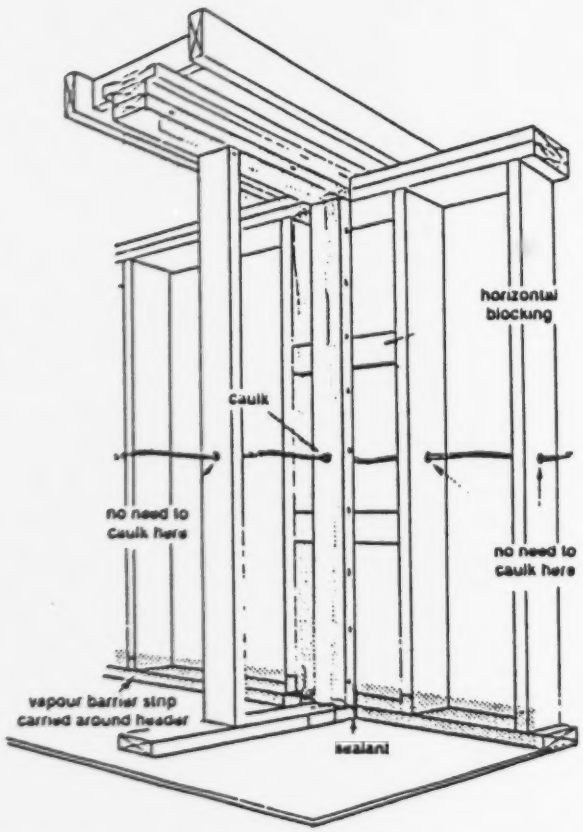
Polypans and polyhats must be supported with wood blocking.


cable must enter Polypan through wood frame and be sealed on both sides.
apply sealant bead around flange just before wall vapour barrier is installed.



3) Electrical Wire Runs

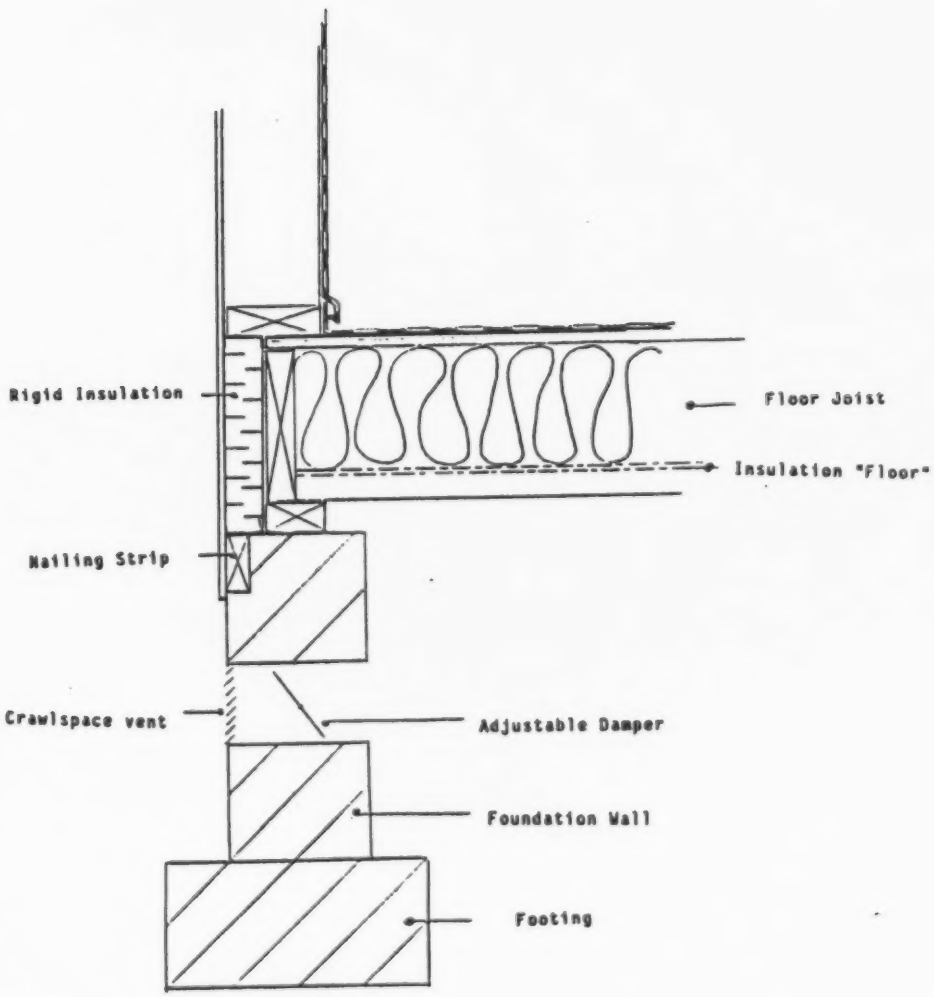
Where possible, wire runs should be in interior partition walls and floors. Where wire runs penetrate to the exterior, the holes through studs or plates must be caulked.



J) Mechanical

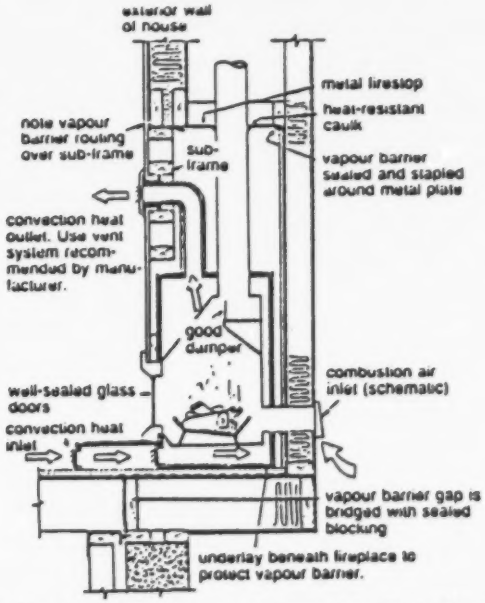
1) Heating System - Chimney

The chimney opening through the ceiling should be sealed to the metal firestop with heat resistant caulking material. The outer edges of the firestop should be sealed to the air barrier with caulking.



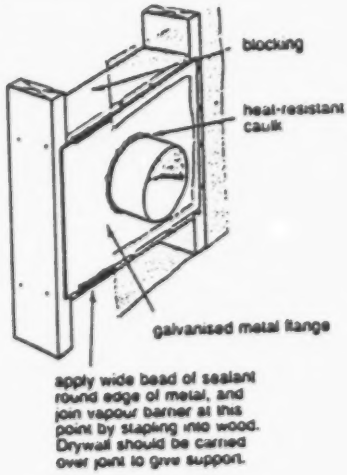
2) Heating System - Wood Burning Devices

Where fireplaces are used, they must be provided with exterior combustion air, glass or metal doors, and tight flue dampers. Woodstoves should be air-tight. All wood burning devices should be supplied with their own fresh air supply.


exterior wall of house
metal fireslop
heat-resistant caulk
note vapour barrier routing over sub-frame
sub-frame
vapour barrier sealed and stapled around metal plate
convection heat outlet. Use vent system recommended by manufacturer.
good damper
combustion air inlet (schematic)
well-sealed glass doors
convection heat inlet
vapour barrier gap is bridged with sealed blocking
underlay beneath fireplace to protect vapour barrier.

3) Heating System - Fresh Air Openings

Fresh air openings through foundation walls should be prepared for air tightness as shown in the following diagrams:


blocking
heat-resistant caulk
galvanised metal flange
apply wide bead of sealant round edge of metal, and join vapour barrier at this point by stapling into wood. Drywall should be carried over joint to give support.

K) Air Vapour Barrier and Drywall Application

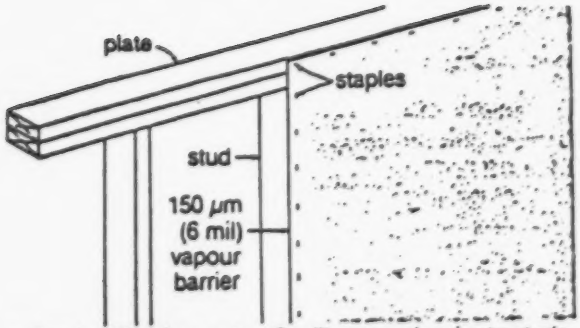
1) The air vapour barrier should be continuous 0.15mm (6 mil) polyethylene around the total shell of the structure, as demonstrated in the preceding sections.

2) All vapour barrier joints should be made against solid wood backing with a continuous bead of caulking.

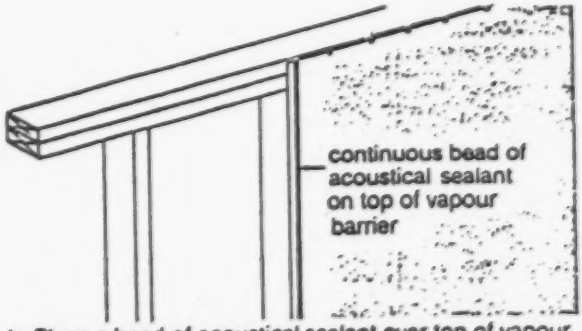
3) All polyethylene sheets should be stapled every 150 mm (6"), or more often in difficult corners.

4) 100 mm - 150 mm (4" - 6") extra polyethylene should be left in corners to prevent damage from drywall application.

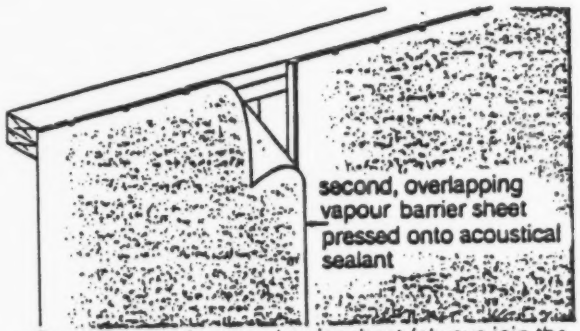
5) Wind loading can rip down the vapour barrier during application. In high wind situations, leave out a section of vapour barrier in the ceiling or wall of approximately 10 m^2 (100 Ft^2) dimension. Apply all other wall board and then the final section of vapour barrier only immediately before wall board application.



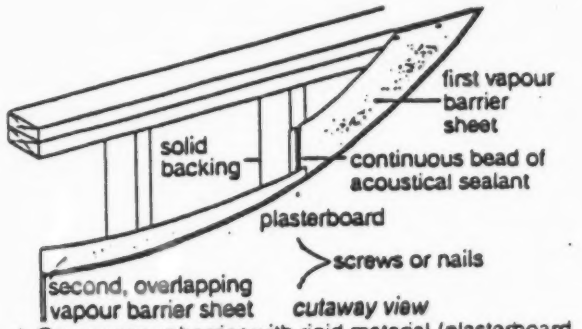
a. Staple 150 micrometre (6 mil) vapour barrier to studs and plates



b. Place a bead of acoustical sealant over top of vapour barrier, ensuring that the sealant is continuous and in line with the stud



c. Overlap second vapour barrier sheet (always join the vapour barrier over a solid backing such as a stud)



d. Cover vapour barrier with rigid material (plasterboard, wallboard, etc.)

6) Inspect and repair any damages to the air-vapour barrier before application of the drywall or wall board material.

7) Measure and pre-cut all wall board before applying it over the air-vapour barrier.

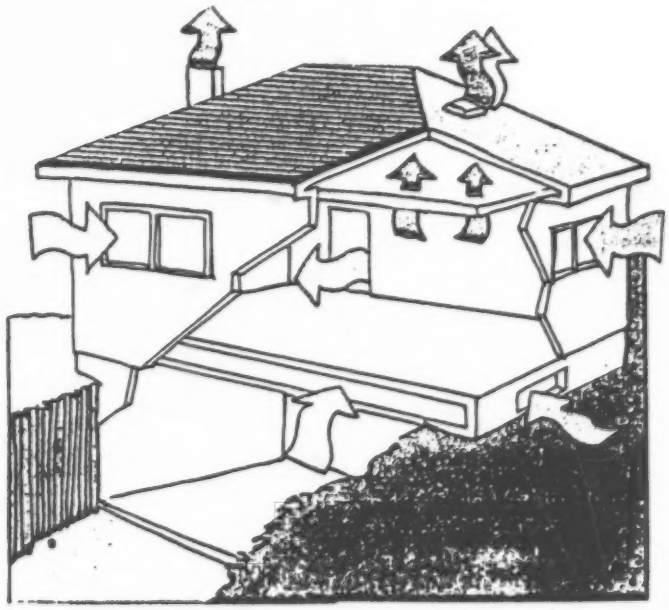
SECTION 2

The following guidelines illustrate the minimum specifications and construction techniques which should be followed when improving the air-tightness and insulation of existing housing.

In most houses, warm moist air escapes from the house into the attic or walls through tiny cracks, holes, electrical fixtures, and other openings. Some of this moisture condenses and freezes in the wall or attic, but usually does not cause problems because ventilation air (the flow of dry outside air though the attic or walls) removes the moisture to the outdoors.

If insulation is added to the attic (or walls) without first air-tightening the attic, then the warm moist inside air continues to flow into the attic through cracks and holes. The added insulation will lower the temperature of the attic space and more water vapour will condense and freeze in the attic. This can cause a large amount of frost build-up in the attic or walls.

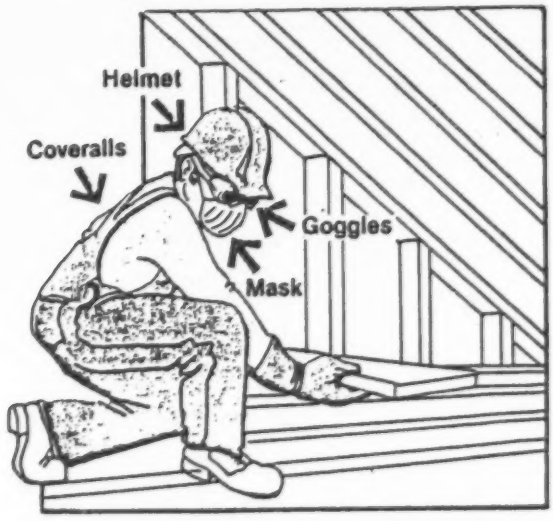
In spring, when the frost build-up thaws, water will run through the ceiling and walls, and can cause serious damage to the house.



Air-sealing cracks and openings in ceilings, walls, doors and windows before adding insulation reduces the problems of condensation in walls and attics.

A. HOW TO SEAL THE ATTIC

1) Use proper safety equipment when working in the attic



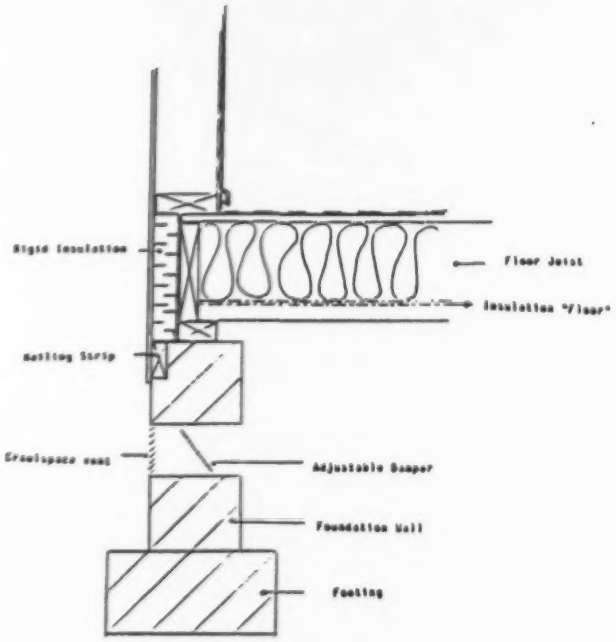
2) Place a board over the top of the ceiling joists to form a walkway. **DO NOT STEP BETWEEN THE JOISTS.** The ceiling below will not support a person's weight.
3) Pull back the insulation where necessary to locate cracks formed along interior walls. Seal the cracks with non-hardening caulking compound.
4) Use caulking compound to seal holes for electrical wiring and to seal around electrical boxes (BE CAREFUL THAT POWER IS SWITCHED OFF before working around electrical fixtures.)
5) Use caulking compound to seal around vents where they pass through the attic floor. Also place extra insulation around the vents.

B. CHIMNEY

1) The chimney should be carefully sealed against air leakage with non-combustible asbestos board or sheet metal.

2) Accurately cut two pieces of metal or asbestos board to fit around the metal chimney flue and install from the upper side of the ceiling joists.

3) A retaining box should then be constructed around the chimney to maintain all insulation and combustible materials at least 50mm (2") away from the chimney.

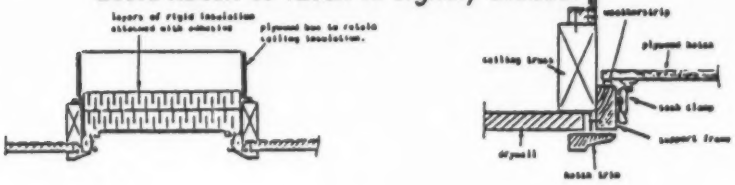


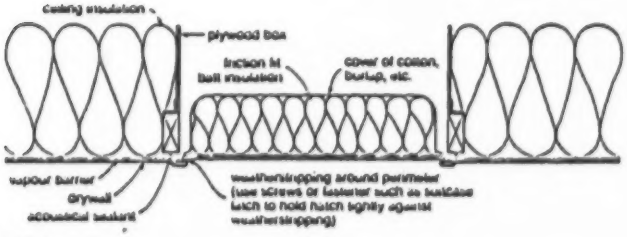
C. ATTIC HATCH

1) The attic hatch is just like a door to the outside. Seal around the frame and between the casing and the ceiling board. Apply appropriate weatherstripping along the edges of the casing or the access panel.

2) Insulate the hatch by attaching insulation to the attic side of the access panel. Insulate the hatch to the same thickness as the rest of the attic.

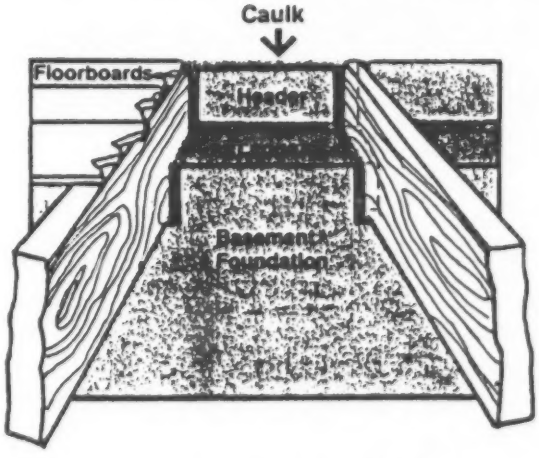
3) Attach a set of hooks or latches to the underside of the attic hatch to latch it tightly closed.




Ceiling insulation
plywood box
Inches of loose fill insulation
cover of cotton, burlap, etc.
vapour barrier
drywall
acoustical sealant
weatherstripping around perimeter (use screws or fasteners such as hold hatch tightly against weatherstripping)

D. BASEMENT

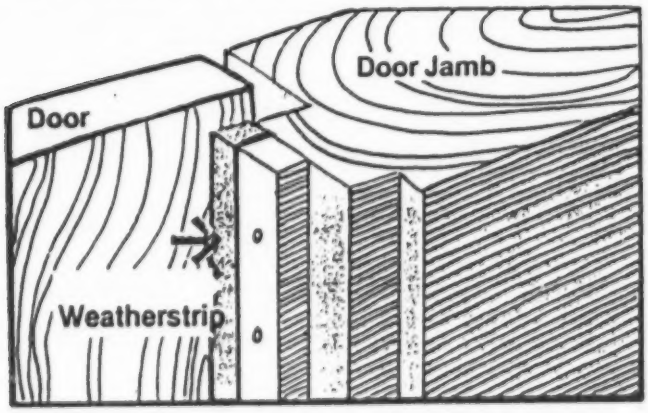
1) It is important to seal all cracks and openings in the basement. Use caulking compound to seal between



the concrete walls and the subfloor, and around floor joists where they penetrate the basement wall. Fill wide cracks with insulating material before caulking.

E. WOOD FRAME DOORS:

1) Close the door to install appropriate weatherstripping, pressing the strips lightly against the door while nailing.
2) Install door sweeps to the door bottoms.
3) If the door is made of thin plywood, or if it is badly worn or warped, replace it with a solid insulated door which is a least 50 mm (2") thick.



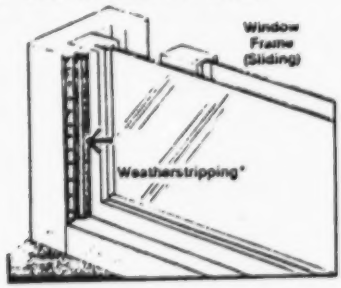
F. METAL FRAME DOORS:

1) Make sure weatherstripping is in good condition. Replace with a heavier weather strip if necessary.
2) Install door sweeps to the door bottoms.

G. WINDOWS:

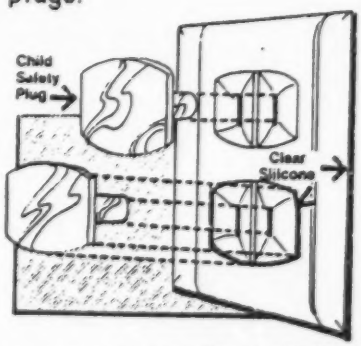
1) Seal between window casings and inner walls with silicone seal.
2) Seal swing-out (casement or awning windows with attached weatherstripping.)
3) Seal sliding windows with spring metal or plastic weatherstripping.

4) To conserve heat, close curtains (On sunny days, open curtains on south facing windows.)
5) Windows that are never opened can be sealed shut with silicone seal.
6) Apply silicone seal to any storm windows that are never removed. (First ensure that inside windows are well sealed.)
7) Permanently insulate and seal windows that are not necessary for light or ventilation.
8) If a plastic storm window is being added to windows during the winter, place the plastic storm window on the INSIDE of the window rather than on the outside. This will reduce condensation on the glass and increase the life of the window. Ensure that the plastic is very well sealed to interior of the window frame.



H. ELECTRICAL OUTLETS

1) To decrease drafts around electrical plug outlets and switches, install ready made foam gaskets or seal electrical plug or switch cover plate to the wall with silicone caulking.
2) Switch off the power before removing cover plate from switches or plugs.



3) Remove the cover plate and install the ready made foam gasket between the receptacle and the cover plate.

4) Install child safety plugs in plug holes that are not used. This will prevent drafts through the outlet holes. **WARNING: The Electrical Code does not allow any insulating or other foreign material to be placed inside the electrical outlet box.**

I OTHER CRACKS AND OPENINGS

1) Use some tissue paper or the back of your hand to find any cold drafts that may be coming through cracks in the walls. For best results, check the west wall when the wind is from the west, the east wall when the the wind is from the east, and so on.

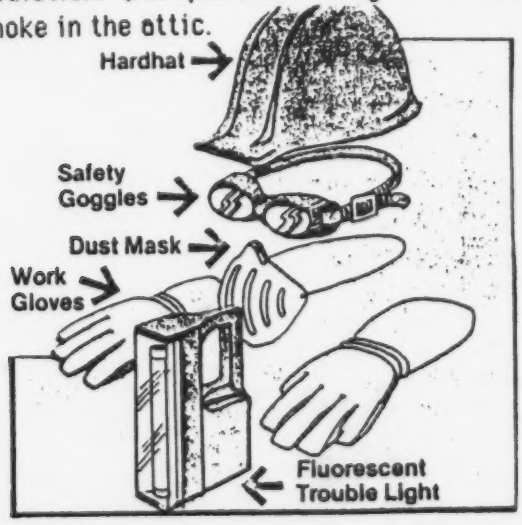
2) Caulk along all baseboards, windows and door trim, and between all sheets of panelling.

3) Seal up any drafts with silicone seal or other appropriate materials.

INSULATE ONLY AFTER AIR SEALING AS DESCRIBED ABOVE

J. INSULATION

1) **Use Safety Equipment.** Wear a dust mask, hard hat, safety goggles, and work gloves. Use a glass-enclosed or fluorescent trouble light when working with insulation. (An open bulb can ignite insulation) Don't smoke in the attic.

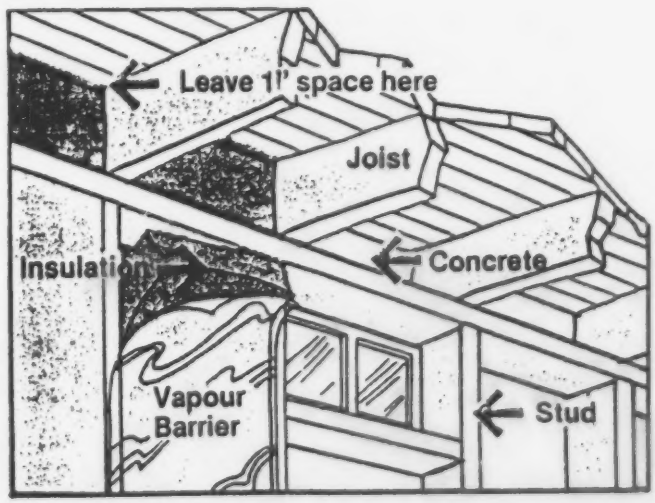


K. ATTIC INSULATION:

1) To avoid a fire hazard, have all attic wiring and electrical fixtures checked by a qualified electrician or local electrical inspector before insulating. Enclose all wiring connections in junction boxes and replace any wiring which has deteriorated electrical insulation.
2) When adding fiberglass batt insulation, place the first batt between the ceiling trusses or joists, and fill any gaps between the batts with a loose fill insulation. The second layer of batt insulation may be installed at right angles to the ceiling trusses or joists (and at right angles to the first layer of insulation). Fill all gaps between insulation batts with loose fill insulation.
3) Attics should be insulated to a minimum level of RSI 7.0 (R 40)
4) Do not insulate within 50 mm (2") of the chimney
5) Do not insulate within 150 mm (6") of any recessed light fixture, exhaust fan or electrical motor.
6) Do not obstruct attic vents. The area of attic vent openings should be .1 square metre (1 square foot) of unobstructed vent openings for each 28 square metres (300 square feet) of ceiling area.

L. BASEMENT

1) Install insulation in uninsulated areas
2) Insulate between the floor joists along the outer walls.



3) It is very important to apply a tightly sealed air-vapour barrier over the basement insulation, to protect the wood studding of the basement wall from moisture condensation.

M. CRAWLSPACE

1) Insulation in crawlspace floors can be increased from underneath where there is sufficient room with batt insulation secured between floor joists under the existing insulation.

2) Crawlspace walls can be insulated with fiberglass batts or rigid board insulation placed on the interior of the foundation wall.
NOTE: Insulating the crawlspace wall will ONLY BE useful if closing vents are installed in the crawlspace. These vents should be tightly sealed during the winter heating season, and opened for ventilation and crawlspace drying during the non-heating season.

N. WALLS:

1) If the walls are not insulated, batt insulation can be added by removing the interior wood paneling, installing the insulation and an air-tight vapour barrier, and replacing the interior wood panels. The air vapour barrier should be installed on the walls according to the techniques outlined in this handbook.

COST TO AIR-TIGHTEN AND INSULATE THE 'AVERAGE' EXISTING HOME IN FOND-DU-LAC

The following cost estimate outlines the material and labour requirements to improve the air-tightness and attic insulation of an "average" home in Fond-Du-Lac. The "average" home was determined by the 15 home survey conducted in the Spring of 1984. All homes in the community require the air-tightening procedures outlined in this estimate. The only variation from home to home will be the actual amount of insulation required. The average home size is 7.3 m x 9.8 m (24' x 32').

The cost of materials has been estimated from Regina retail material prices as of Fall 1984. The estimated cost of materials delivered to Fond-Du-Lac has been increased from Regina prices by a factor of 1.5

The cost of labour in Fond-Du-Lac has been included at $8.00 per hour.

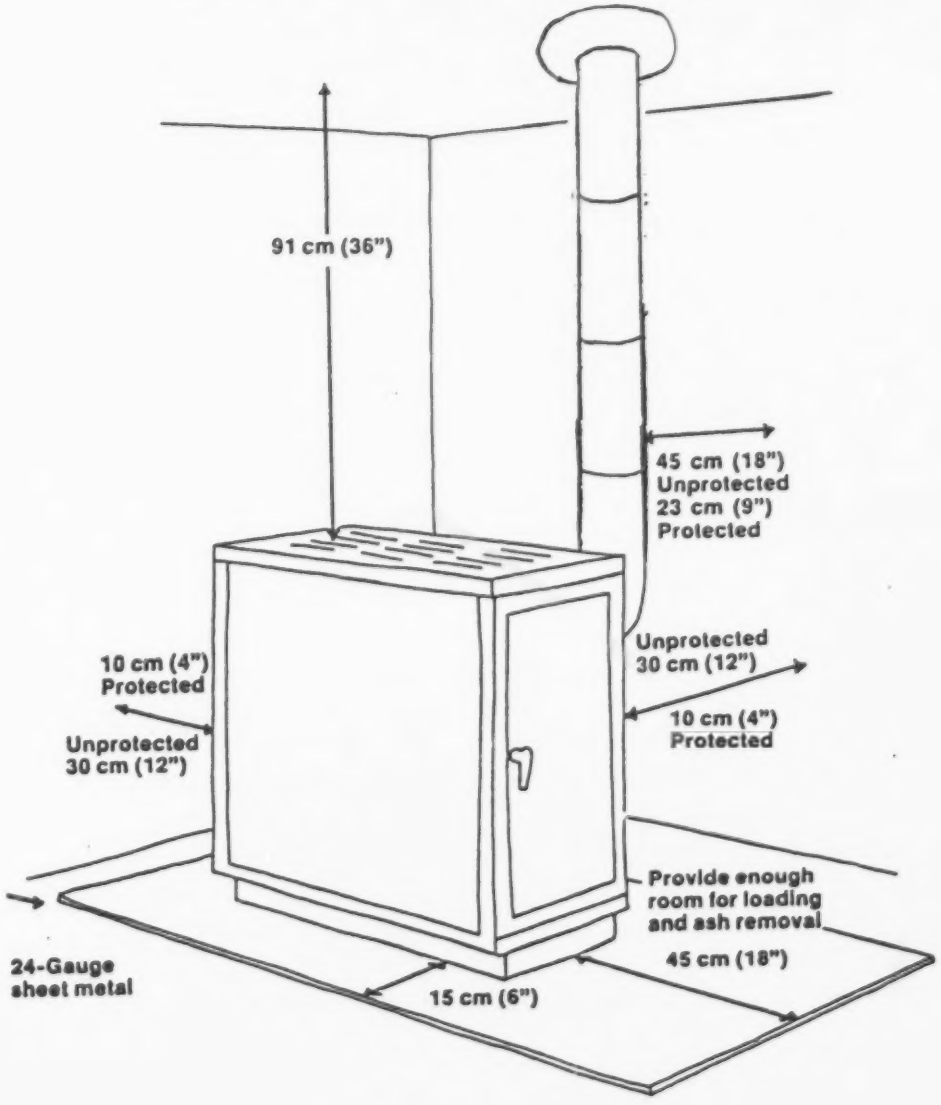
ACTIVITY	MATERIAL COST (Regina retail price X1.5 factor) $	LABOUR COST $
1. Caulking of all wall-cracks, baseboards, door and window trim:		
◇ 8 tubes silicone caulking	65.00	
◇ 4 tubes acoustical caulking	24.00	
◇ 10 Hours Installation		80.00
2. Electrical plug and switch gaskets:		
◇ 20 gaskets and safety plugs	15.00	
◇ 1.5 hours installation		12.00
3. Square door and tighten latch to accommodate new weatherstripping		
◇ 2 hours labour		16.00
4. Weatherstrip door and install threshold sweep		
◇ 1 set door weatherstripping	18.00	
◇ 1 set threshold sweep	6.00	
◇ 1 hour labour		8.00
5. Weatherstrip Opening Windows		
◇ 3 packages weatherstripping	15.00	
◇ 2 hours labour		16.00
6. Install plastic storm windows INSIDE window frame		
◇ reusable plastic storm window material and mounting strips for 8.5m^2(90 ft^2) glass	115.00	
◇ 4 hours labour to install		32.00
7. Insulate Attic		
◇ Increase insulation from RSI 3.5 to RSI 7.0 (R 40)	380.00	
◇ 6 hours labour to install		48.00
TOTAL MATERIALS	$638.00	
TOTAL LABOUR		$212.00
TOTAL DIRECT COST PER HOUSE:		$850.00

SECTION 3

A. DRYING THE WOOD:

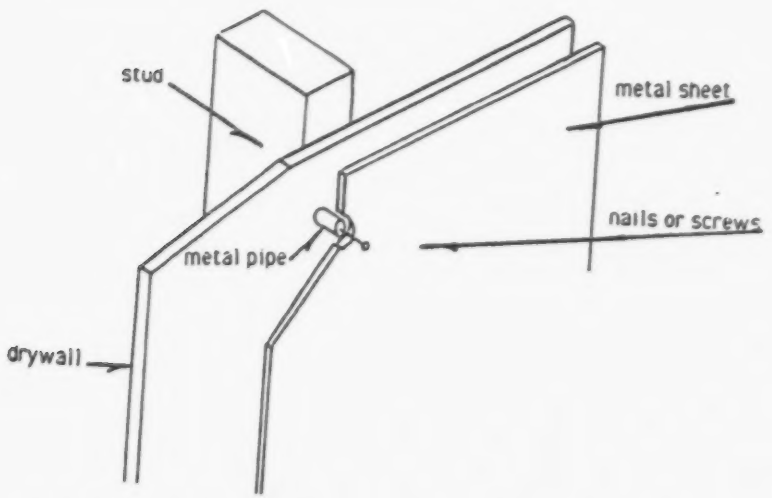
Freshly cut wood is "green" or "unseasoned" and contains a large amount of moisture. It burns inefficiently and can lead to formation of creosote - a tar-like, flammable substance - in the stove pipe or chimney. Wood should be air-dried or seasoned for several months before being used as fuel. Ideally, firewood should be cut, split and piled one season ahead of when it is to be used.

B. INSTALLING A VALLEY COMFORT STOVE:



C. PROTECTING THE WALL:

The walls around a stove should be protected with .33mm (.013") sheet metal. The sheet metal should be spaced out 25mm (1 inch) from the wall, with non-combustible spacers. The spacers can be made from pieces of pipe placed between the sheet metal and the wall.



D. CLEANING THE CHIMNEY:

Wood smoke contains unburned gases and small drops of tar-like liquids. When wood smoke is passing through the chimney it condenses to form creosote on the cool inner surface of the chimney. These deposits of creosote in a chimney or stovepipe can cause a fire. Creosote should be removed regularly to prevent the possibility of a chimney fire.

The chimney can be inspected through the ash cleanout or from the roof. If a layer of more than 5 mm (1/4 inch) of creosote has formed, the chimney should be cleaned with appropriate brushes and tools. Metal chimneys should only be cleaned with a soft bristle brush to prevent damage to the inner surface.

Creosote forms most overnight, when low fires smoulder in airtight heaters. More frequent wood stoking and hotter fires tend to retard creosote formation. Minimizing low smouldering fires will reduce creosote collection in the chimney.

There is no evidence that chemical flue cleaners prevent creosote buildup; chemical cleaners are not a substitute for regular inspection and cleaning.

E. FIGHTING CHIMNEY FIRES:

What is a chimney fire?

A crackling sound can often be heard at the beginning of the fire. As the intensity of the fire rises, the stovepipe will probably glow red and a tall plume of flames and sparks will rise from the top of the chimney. The stove pipe or chimney can become hot enough to ignite combustible material within a few inches of the pipe. The sparks and cinders shooting out of the top of the chimney can ignite the roof of the building and cause a house fire.

F. COMBATTING A CHIMNEY FIRE

The best way to stop a chimney fire is to limit the air supply to the stove. Close all drafts and dampers and close the chimney openings by plugging them with a metal sheet or stuffing them with a wet blanket. Use wet blankets to cool the walls and surfaces around the hot stovepipe and chimney .when the chimney fire is being brought under control.

G. SAFETY EQUIPMENT

Homes heated with wood should be equipped with at least one smoke alarm, an all-purpose fire extinguisher and a covered metal container for storing ashes.

Family fire drills should be conducted regularly to ensure safe exists from the home in case of a fire.

Fond-du-Lac, Saskatchewan